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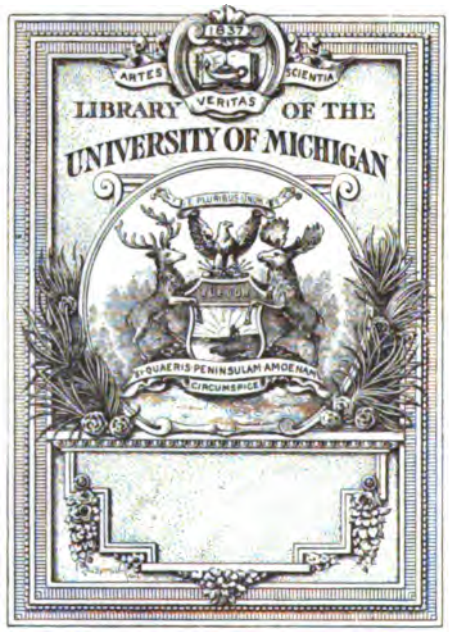

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WORLD'S COLUMBIAN EXPOSITION,
CHICAGO, ILL., 1893.

REPORT

OF THE

COMMITTEE ON AWARDS

OF THE

WORLD'S COLUMBIAN COMMISSION.

SPECIAL REPORTS

UPON

SPECIAL SUBJECTS OR GROUPS.

IN TWO VOLUMES.

Vol. II.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

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HONEY AND BEES.

BY

EUGENE SECOR.

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HONEY AND BEES.

By Eugene Secor.

The landing of the caravels on the shores of the New World marked an epoch in the world's history. Four hundred years, occupancy of this Continent by the Caucasian race was fittingly commemorated by the Columbian Exposition. The celebration of the discovery of America by Columbus furnished the American people an occasion to review the progress made along many lines of thought and industrial activity never before enjoyed. At that marvelous aggregation of the world's products there was an opportunity for comparison, for study, for instruction in science, in art, in manufactures, and in the products of the field, mine, and forest, which was only circumscribed by the limitations of time and the endurance of the student. As in other lines of activity specialists delight to compare notes and record advancements made, so it is interesting to the bee keeper to review the progress made in the domain of apiculture.

It is supposed that bees appeared on the earth in the cretaceous period, or at the same time that flowering plants were created. That the earth might the more speedily and effectually be clothed with luxuriant vegetation, bees, which act as marriage priests to the flowers, were needed for the highest development of plant life. It is probably true that when man appeared on the earth he found the nectar of flowers in the form of honey already stored for his use. We assume that the bee industry is as old as the dairy, and that milk and honey were among the articles provided for the sustenance of man from the earliest times. Sugar is a comparatively recent invention. Honey is as old as the race.

We have very early mention of honey as an article of food and commerce, and if the bee of that period was not identical with the *Apis melifica* of the present time, it must have been a near relative. As early as the time of Joseph the land of Caanan was celebrated for its delicious honey. That was one of the dainties which Jacob ordered his sons to take to the Egyptian ruler as a peace offering when they went down the second time to buy corn. No higher recommendation for any country was then known than to say it was a land "flowing with milk and honey." It is also mentioned in Ezekiel, chapter 27, as an article of commerce between the Jews and the inhabitants of Tyre

six hundred years B. C. The fragmentary history preserved of that early period gives us but little insight into the art of bee keeping. It is not likely, however, that bees were domesticated to any considerable extent, if at all. Being natives of a mild climate, where they needed no protection except that afforded by caves and hollow trees, they multiplied rapidly no doubt, and the ancients had only to appropriate the stores the bees had provided for their own future use. Later, we learn that bees were kept (as they are to-day in some Eastern countries) in cylindrical earthen tubes open at both ends, from which the peasantry broke the honey-laden combs and either sold or used it in that broken condition or pressed the liquid out in the most primitive fashion. Of course that obtained in the last-mentioned manner was more or less contaminated by dead bees, pollen, and soiled combs which injured the color and taste, and was a very inferior article compared with the pure nectar of flowers thrown from the combs by centrifugal force as now practiced by progressive and skillful apiarists. Modern bee keeping is quite a different thing from the practice of those times. Indeed, it is less than a hundred years since the foundation was laid for a more intelligent prosecution of the industry.

When the observations of Francis Huber were made public an impetus was given to the subject which has increased to the present time. From him we obtained the rudiments of the knowledge of the honeybee which was the beginning of scientific apiculture. Ignorance of the natural history of bees and its almost certain concomitant—superstition—began to give way to a more rational belief and intelligent practice. But as ignorance is always slow to recede before the advance column of a more enlightened theory, it was nearly fifty years later—not a half century ago—when Dzierzon in Germany and Langstroth in America, each unknown to the other, developed a system of management in the apiary that revolutionized bee keeping. It made the hive an open book to every investigator. That system was the invention of the movable comb hive. Since that time advancement has been rapid and constant. It is probably within the bounds of truth to assert that more real progress has been made in apiarian knowledge and in the development of honey production in the last fifty years than in all previous recorded time.

Within the memory of men now living, a book on the natural history of the honeybee, or on scientific bee keeping, was a thing unknown. The internal economy of the beehive was as much a mystery as a dream. The bee was accredited with superhuman wisdom by the peasantry of all countries. Now thousands upon thousands of eager students are prying into the secrets of this newly found worker for man's benefit, and ransacking the world for improved bees and methods. Quite a library can now be obtained, devoted exclusively to the subject of bees and bee keeping. In the English language alone we now

recall creditable volumes by such learned authors and skilled bee keepers as Cheshire, Cowan, Simmins, Langstroth, Quinby, Cook, Newman, Root, Miller, Dadant, and Doolittle, besides numerous brochures on some special phase of the subject. There are also published in this country alone the following journals devoted exclusively to bee keeping and its kindred pursuits: One weekly, one biweekly, five monthlies; while nearly all of the agricultural weeklies and monthlies devote a portion of their space to the apiary under the editorial charge of some practical bee keeper. Thus, apiarian knowledge is disseminated through the press.

BEE KEEPERS' SOCIETIES.

It is but little more than thirty years since the first apicultural society was organized. In some of the countries of Europe—notably, Switzerland, Germany, and Austria—societies have multiplied, nomadic instruction in apiculture has been adopted and has proved so beneficial and popular that a course in apiculture has been included in some of their agricultural colleges. Societies in the above-named countries have at times numbered six or seven hundred members, and the subscribers to their society reports more than twice as many. In Great Britain the British Bee Keepers' Society is very successfully managed and influential. It grants certificates of ability to experts who are permitted to lecture before conventions, affiliated societies, and farmers' meetings in the Kingdom. Ontario, Canada, grants her leading society a small annual appropriation for the encouragement of this growing branch of rural economy. In our own country the North American Bee Keepers' Society was organized twenty-four years ago. It is intended to be both representative and local in its character and influence, and is moved annually to accommodate as many bee keepers as possible in our vast country. Many of the States have State societies with annual meetings. County and district societies are also numerous.

EXPERIMENT STATIONS.

So important has the subject of apiculture become that several of the State experiment stations have authorized original investigations by practical and scientific experts to settle, if possible, some of the many unsolved problems that confront the honey producer.

The importance of the honeybee in the economy of nature has long been recognized by scientific bee keepers, but not so fully by horticulturists and farmers from lack, no doubt, of sufficient knowledge on the subject. But through apicultural societies and publications there seems to be a better understanding between them and an admission on the part of most horticulturists that the hive bee is an important agent in the pollenation of many of the fruits, and that no injury is done to blossoms or fruit by the bees. Experiments have been conducted

proving that bees never injure sound fruit, and that the beneficent offices performed by them for the horticulturist, the market gardener, and the farmer are of such value that the industry of bee keeping should be encouraged by every proper means. That it is encouraged by governments generally is proved by the establishments of experiment stations and appropriations by States and provinces in the interest of bee keepers. But as the science and art of bee keeping is becoming better understood the tendency is toward specialization. Instead of a few colonies kept by each farmer as was formerly done, men trained in all the knowledge necessary to success manage apiaries aggregating, in some instances, two thousand colonies, kept in separate localities, called out-aparies. It has not been found profitable in this country to maintain in one yard more than two hundred colonies.

STATISTICS.

According to compilations by the Government Census Bureau in the enumeration of 1890 the number of pounds of honey produced in the United States in the year previous was 63,897,327. Pounds of wax returned for same year, 1,166,588. At a very moderate average price for these products their value is nearly $7,000,000. If the year 1889 was not an average one, which I believe was true, then the value of the average crop of honey in the United States would exceed the above estimate. Honey being a distillation in nature's floral laboratory, the supply depends largely on atmospheric or meteorological conditions. To get a fair average of the annual production a series of consecutive years should be taken. The above-mentioned aggregate of honey produced in one year is but a small fraction of the honey resources of the country. This is shown by the enormous amounts produced by specialists within limited areas. The areas so occupied and developed are but the beginnings of possible production.

EXHIBITS AT THE WORLD'S FAIR.

The exhibits in the apiarian department of the Columbian Exhibition were mostly installed in the east gallery of the agicultural building. Glass cases were provided by the States and provinces competing, under the direction of the Agricultural Department. These cases were uniform in size and were about 5 by 20 feet, 6 feet high, inside. A glance through this gallery revealed the fact of tons of honey displayed in every conceivable form that the fancy of the producer and the ingenuity of the superintendent could dictate. Besides the glass cases were many exhibits of bee keepers' appliances, consisting of hives, supers, honey extractors, sections, foundation mills, machines for putting sections together and automatically fastening the starters, smokers, honey knives, escapes, etc. Some old-fashioned round straw hives, so familiar in illustrations for the past hundred years, were

there to show the methods employed by bee keepers of past generations. Alongside of these were exhibited the modern movable frame hive with various contrivances for obtaining honey in its purity and in the best marketable shape.

The comb honey on exhibition was mostly in 1-pound section boxes, made of white poplar or linen, some of which were glassed on both sides, but whether glassed or not generally built between separators, giving to the finished product an even and handsome appearance, no matter what the source from which gathered. There were many fanciful designs and mottoes worked out by the bees in comb honey.

Extracted honey was shown in large quantities. The style of receptacle varied from the small large-mouthed bottle to the large long-necked decanter—in packages adapted to retail trade and in cases suitable for shipment—in its liquid state as taken from the combs, and in granulated form (a condition which most extracted honey assumes when long removed from the hive and exposed to changes of climate).

In addition to the exhibit of honey and appliances there were a number of colonies arranged along the east wall of the building with exits for the bees outside and far above the crowds of people on the ground below. These colonies were successfully managed during the summer and stored a fine lot of honey. They were Italians and Carniolans.

Of the glass cases above referred to, New York filled three with exhibits, besides many fixtures shown outside; Illinois, two, and Ontario, Ohio, Michigan, Iowa, Nebraska, Indiana, Minnesota, and Wisconsin each, one. States and Territories having entries in smaller quantities, and in some instances shown in their agricultural sections below, were California, Washington, Nevada, Colorado, and Maine. Many of the States had superintendents in charge of their apiarian exhibits whose pleasure it seemed to be to impart instruction to the interested visitor. Much useful information was no doubt disseminated thereby.

The exhibits from the States did not adequately represent the industry in all parts of our vast domain. The reason for this lay chiefly in the fact that the State appropriations for the fair were in many cases too small to properly represent all the industries. Many States noted for their fine and large crops of honey made no exhibit or only a few samples from some patriotic apiarist.

Only those States which granted a liberal sum to the bee keepers were creditably represented. A minor reason probably influenced the bee keepers in some of the States to withhold exhibits. As before hinted, the yield and quality of honey being largely due to climatic influences, and the conditions in 1892 not being favorable, they lost interest in the matter because they could not show what they deemed worthy of exhibition.

FOREIGN EXHIBITS.

Aside from the fine exhibit from Ontario, which showed that the bee keepers of that Province were among the foremost in the world, the foreign exhibits were mostly confined to liquid honey and apiarian appliances, and were not shown in the east gallery of the agricultural building, but were among the foreign exhibits, either in other parts of the agricultural building or in other parts of the grounds. The British bee keepers society had a large and exceedingly interesting collection of extracted honey from different localities in England, Scotland, and Ireland, put up in bottles of uniform size and style and made attractive by finely printed labels. The other countries exhibiting honey, or appliances, or both, were: Italy, Greece, Russia, Ottoman Empire, New South Wales, Ceylon, Siam, Spain, Argentine Republic, Republic of Ecuador, Guatemala, Brazil, Costa Rica, Haiti, Mexico, and Venezuela.

These foreign honeys were subjected to the disadvantages of change of climate, want of freshness (as they were all of 1892 crop or earlier), and lack of persons in charge who understood how to properly care for them, but much fine honey was shown in spite of unfavorable conditions.

Russia exhibited a very interesting collection of hives and models of hives, and implements used in the apiaries of that country, showing that modern ideas have taken root in the minds of the Russian bee keepers.

LESSONS TAUGHT BY THE EXPOSITION.

Observing bee keepers could not but learn that quality in honey is essential to the highest success. The low price of sugar brings it into use in every family in the country. Honey therefore becomes a luxury, as it can not be produced at a profit in competition with cane sugar or glucose syrup. If these facts are conceded by the honey producer, the only way to improve his condition is to improve the quality of his product. If the matter were left entirely to the bees, there would be little difficulty, but since the invention of the extractor much liquid honey is taken in an unripe state, with consequent deterioration of quality, injuring the sale not only of this particular lot, but of good honey as well.

It is now generally understood by the foremost bee keepers that nothing but the finest should ever be put on the market for table use, the cheaper grades being sold to bakers and manufacturers.

In the production of comb honey, the style of box, the manner in which the comb is finished by the bees, and its general neatness has much to do with its general acceptance by the public. The section box should be well filled, the comb straight, all sealed, the wood white and thoroughly cleaned of all stains; in fact, it must be as near perfect as possible to insure the highest price.

It can be said to the credit of American bee keepers that they are not only the largest producers in the world, but that the quality of their products compared favorably with the best from other countries, while in the matter of improvements they are undoubtedly ahead of any other nation.

The enterprise shown in the importation of bees from the Old World is highly commendable. The earth has been ransacked by Americans for improved strains. Bees from Italy, Syria, the Isle of Cyprus, Egypt, and Carniola have been introduced and are now bred in this country.

Probably the most important inventions and the most practical appliances have been in the method of securing comb honey. The section boxes now in use and the arrangement for rapidly handling them in the apiary are a great advance over the practice a quarter of a century ago, while in the machinery for making hives, sections, and for the manufacture of comb foundation for starters there would seem to be little chance for improvement.

HOROLOGY.

BY

CHARLES F. CARPENTER, M. D.

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HOROLOGY.

By CHARLES F. CARPENTER, M. D.,

Honorary Commissioner of the United States at the Vienna International Exposition of 1873; Member of the International Board of Judges, World's Columbian Exposition, 1893.

The Government reports on the Vienna Exposition in 1873 and on the Centennial Exposition at Philadelphia in 1876 contain full information in regard to the progress made in this group to these dates. We will therefore notice principally the changes and improvements made during the past seventeen years. There were exhibits from our own country, Switzerland, Germany, France, Russia, Great Britain, Sweden, Denmark, New South Wales, and Spain, showing the degree of excellence they have acquired in this industry.

It must be taken into consideration, in regard to the large number of awards given to foreign countries, that before their exhibits were sent here they were submitted to committees for their judgment in selecting the best as deserving to represent their skillful handiwork. When we consider the importance of instruments for keeping time in regulating the affairs of mankind, aiding the astronomer in his nightly vigils, guiding the mariner over the pathless ocean, controlling the movements of railway trains, and giving security to the lives of millions of travelers, we can form some idea of their great value. Representing as this group does the utmost skill of man in bringing to such marvelous perfection one of the most wonderful productions of mechanical skill he is capable of constructing, it should excite our greatest admiration. It is not only the mechanical execution we should consider, for the mechanism embraces principles deduced from the highest branches of science, which but few men in the world understand well enough to apply practically and successfully to instruments for keeping time. Fifty years ago England was unrivaled in this industry; now not one in ten thousand watches sold in this country is of English make. Their detached or patent levers having a fusee and chain were generally regarded as giving the best results, and for a long time continued most in demand. A Swiss writer in 1878 said: "The English then went complacently asleep in the conviction of having set up limits which their rivals or successors could never excel." At this early time watches without a fusee and chain, with anchor or lever escapements, of excellent construction and finish, were made in Switzerland, but

owing to the very limited knowledge among watchmakers of the possible performance of an isochronal balance spring in regulating the effect of the varying force exerted by the mainspring, the fusee and chain system still continued mostly in use. The Jürgensens and Swiss made watches with isochronal balance springs whose performance convinced those who used them that the fusee and chain might be left out and yet a satisfactory result in time keeping obtained. Then came the American watch companies with their millions of watches made by machinery, all without a fusee and chain, depending upon an isochronal balance spring to correct the variation in time keeping, caused by the varying force of a mainspring.

As a result of the exhibits at the Centennial Exposition the Swiss and English makers became alarmed at their future prospects in this important industry. A Swiss commissioner and juror after his return home said:

> Had the Philadelphia Exhibition taken place five years later we would have been totally annihilated without knowing whence or how we received the terrible blow. We have believed ourselves masters of the situation when we really have been on a volcano, and to-day we must actually struggle if we do not want to encounter in all the markets that rival manufacture. It remains for us to profit from this sad experience and improve our manufacture.

They went earnestly to work and with the aid of schools of horology established at Geneva, Locle, Chaux de Fonds, Neuchatel, St. Smier, and Bienne have wonderfully improved their watches in principles of construction, cheapness, and, as we see by their observatory certificates, in keeping time. They have a hereditary skill in their handiwork acquired through over nine generations of experience, and with the aid of technical schools, under the direction of their most skillful men of genius, their productions now have attained to the rank of the fine arts, and are getting the favor of our dealers and the public to such an extent that is going to be severely felt by our great watch factories.

In our report on the Vienna Exposition twenty years ago we wrote:

> The wonderful advance made in watch making in our own country is one of the remarkable instances in which an entirely new industry has been taken up, an immense product put upon the market, and a national reputation established in about twenty years, competing successfully with countries that have been engaged in it since its infancy, aided by exceedingly low prices for labor. To sustain the position we now hold, apart from further progress, will require the utmost energy and skill we have at our command.

The question will now come up, Have we sustained relatively that position, and how much progress have we made? We have the mechanical skill and ingenuity to make wonderful and effective automatic machines for forming and finishing the different parts required; but when it comes to new principles of construction in watches the man must be born to it, and also educated through many years of

experience. Many so-called improvements, made in late years, have already been abandoned, and the same fate surely awaits many of the new constructions now in use. It is remarkable, in looking at the different forms of construction by celebrated makers, to see the individuality shown in them; yet with all it will be very difficult, if not impossible, to find one that has in every part the most approved principles already known.

We find watches well made in immense numbers of all grades and makers, but all have some objectionable points in their construction, which can only be known to those who have an intimate and practical experience through many years of special study of their mechanism. Here is an open field for a person having the proper capacity to assemble in one movement the best construction of individual parts. He must have a superior judgment, resulting from skill and experience, with a special genius to accomplish such a work in this course. Combined with new principles that may be discovered lies the hope of our success in the future, for something of this kind must be done soon to prevent a serious condition of this industry in our country. For several years the "tombillon" watch, invented a long time ago, has given remarkable results, as attested by observatory certificates. This complicated and expensive construction, requires the greatest care and skill when repairs are done to it. Many other watches of delicate and complicated construction such as split seconds, repeaters, and those adjusted for isochronism, position, and temperature, made in Switzerland, come to this country, and their fate will be a sad one unless their owners take the greatest care to place them in competent hands to be kept in order.

The art of watch repairing is now in a deplorable condition in this country. Fifty years ago it was learned under the tuition of a master for a period of about five years, individual skill was recognized and developed, the apprentice became practically proficient, more or less, according to his natural talent, and when he could make a perfect working verge escapement he was capable of doing all the work required at that time; he received but little education in the theory or science of horology beyond that he might get from Reid's Watchmaking, if he was fortunate enough to have access to a copy of it. Now the state of the art is very different; the errors of minutes then are now reduced to seconds; complicated watches in a great variety of constructions, requiring the most skillful manipulation to preserve their adjustments, are everywhere, and when one of them gets into the hands of an incompetent workman, and his name is legion, its constitution is gone; by filing, hammering, or bending, as the case may be, it soon becomes of no use to its owner. In our great product of millions of watches, when a piece is lost or broken its number or description is sent to the material department of the factory that made it, a corresponding piece is returned which may or may not fit exactly, but with

a little fitting at furthest "will do." Consequently a very large number of workmen who have "learned the business," (?) without proper tuition, experience, or capacity, are now doing the general repairs, cleaning, etc. Seldom is found a proprietor of a watch and jewelry store who has more than the slightest knowledge of watch repairing. Consequently he employs workmen at the lowest price, and of course the grade of the work done is as low as the price. The truly skillful repairers of watches are very few in number. A knowledge of the construction and peculiarities of a great many different kinds of watches is required, and a special aptitude to understand in a very short time any new forms of construction that present themselves, so that the fault preventing a proper performance may be located and remedied. This faculty is rarely to be found. Thousands of persons can make the individual parts of watches without a fault, and they are made by a division of labor, but it takes a master mind to reason out, as is often required, the cause of unsatisfactory performance in a watch. And, then, the remuneration is so small for such work that even a competent and skilled artist will often abandon the business and seek some other occupation, where his ability will be properly remunerated, thus too often leaving the work to fall into the hands of unskilled workmen who finally ruin it. The long lever, as used in Swiss "ancre" watches sixty years ago, and more fully developed in the Jürgensen type of watches, appears to be generally superseded by a shorter construction. In some watches it is but slightly longer than one arm of the pallet. This appears to be about as short as it can be made, as it then requires a very small roller. The short lever is adopted by nearly all the best Swiss makers, and in some watches the end of the lever that projects over the escapement wheel, which is left there more for ornament than use, is left off entirely, thus allowing the pallets to be more easily cleaned and preventing the lodgment of fuzzy matter between the free end of the lever and the escapement wheel. Many forms of patent regulators have come into use that will be abandoned after having had their day in serving the retailers as "an important improvement" when selling their watches. There are objections to most of them. When an ordinary regulator fails to improve the rate of running, there is but little or no use for a patent regulator. Thinner and more elastic mainsprings are much in favor and have superior merits. In some watches we find the stop work allows five turns of the mainspring in winding one turn of the mainspring in "getting up," and one free turn that remains after the watch is wound, having seven turns in all. When winding such a watch there is an agreeable feeling that no part of its mechanism is subject to an injurious strain, and that the winding force required has but little variation from the beginning to the end. More attention is being given to balances and balance springs. The improvement in these particular parts is surprising, and the fact that

watches with observatory certificates can be bought in Switzerland for 50 francs goes to show how wonderfully expert they have become in rapidly adjusting balances and balance springs in position, temperature, and isochronism.

Various forms of construction that are very questionable improvements have come into use to prevent injury to the train when a mainspring breaks. In former years, when the Swiss center pinion had very thin leaves, it was not very unusual to find, when a mainspring broke, that one or two leaves of the center pinion were broken by the rebound of the barrel, and sometimes a third wheel pivot was also broken off. This was particularly the case when some incompetent person had put in too strong a mainspring. But where watches are provided with a reasonably thin mainspring, the leaves of the center pinion having a proper thickness, and rounded at the bottom of the leaves instead of being cut square, and the third wheel pivot a proper size, it will very rarely happen that there will be any damage to these parts by a mainspring breaking. The screw-nut center pinion is the simplest and best of all the contrivances in use to absolutely prevent this injury to the train.

Many stem winding and setting arrangements that have been introduced in the past few years are giving great dissatisfaction, and will be the cause of much vexation to owners and repairers of watches. Some of these systems border on the ridiculous, and in the number of pieces used are very objectionable; stem winding and setting work should be made durable and effective, winding smoothly, and with as few pieces as possible. Some makers accomplish this, and have proven the soundness of their principles by many years of use. Nickel movements are most extensively shown, and appear to be greatly in favor with the public; but in artistic beauty and resistance to oxidizing influences they are far inferior to well grained and gilded work. Many so-called nickel movements are really an alloy of soft metals that somewhat resemble nickel, while others are brass, electroplated with nickel.

A new trouble now confronts the watch industry in the liability of watches to be seriously injured by magnetizing influences, thereby affecting their timekeeping qualities to such an extent that they perform in a very irregular and unreliable manner. It is said by many persons that the magnetism can be entirely removed, yet other reliable authorities say that it will reappear after a short time. Various devices have been tried to prevent this trouble, but the entirely satisfactory one is yet to come.

The compensating balance now in general use was invented about one hundred years ago. Its arms and inside rim are made of steel. When it is magnetized it will act like a magnetic needle, pointing north and south, and will be attracted by any iron or steel work that is

near it, causing a very irregular rate in timekeeping. Nonmagnetic metals have been used entirely in making compensating balances. So far they have failed to a great extent in securing the confidence of the public, and consequently are but little used. The balance spring, or hairspring as it is usually called, being made of steel, is also affected by magnetism. Various nonmagnetic metals and alloys have been tried in the place of steel. Some say they have given good results, but the fact that they do not come more into general use shows that their performance is not entirely satisfactory.

It appears that many nonmagnetic watches that have been sold and practically tested have performed tolerably well for a few months, and then began to give such dissatisfaction as to finally result in their being laid aside or returned to the dealer that sold them. Electrical appliances and magnetic machinery are now all around us. Any person carrying a watch is liable to have it magnetized, and consequently lose faith in it as a time keeper. It is therefore greatly desired to have watches that will perform as well as those having steel balances and hairsprings, and yet not be affected by magnetizing influences. We have faith from the result of experiments recently made that this trouble will be overcome by the use of a nonmagnetic balance made of metals having the proper difference in coefficients of expansion in changing temperatures, and at the same time having the rigidity and elasticity required, combined with a balance spring that will have and retain the properties of isochronism and elasticity of flexure.

The author of an English publication says of the firm of Japy Brothers, Beaucourt, France:

> Their production of watch movements began in 1870, and from that time to 1888 amounted to 35,326,930. During 1888 they supplied these movements to Swiss and Besançon manufacturers to the extent of 1,200,000, who case and complete them. Besides these, the firm of Japy have lately taken to manufacturing a complete metal keyless watch at the incredibly low price of 5 shillings—a watch provided, like a real timekeeper, with a barrel and mainspring, a center wheel, third and fourth wheels, an escape wheel, a cylinder with balance and balance-spring motion, dial wheels, and a pair of hands, the whole in rather a tasty case. The work is certainly rough, very rough, but the watch goes, and one taken at haphazard from several boxes which were given us for examination, and which we kept for a fortnight, went very well indeed until we broke the cylinder; then the question of replacing it suggested another train of thought as to the relation of repairs to prime cost.

The foregoing shows what has been done by the aid of labor-saving machinery, division of labor, and an immense capital. These watches, like the cheapest productions made in this country, soon wear themselves out of order, but they answer a purpose to those who wish only approximate time, and that only for a short period.

It is of the utmost importance to the student, when he commences practical work in constructing instruments for keeping time, that he should have a technical education. The schools of horology at Geneva,

Chaux de Fonds, Locle, Neuchatel, Bienne, etc., have had an immense influence in raising the Swiss productions to the high position they now occupy. A glance at the following complete course of studies will show how thorough the instruction is and how assiduously the student must apply himself:

FIRST YEAR.

FIRST PERIOD.

Shopwork.—The pupil learns to file, holding the file with both hands; he makes first a steel ruler, then a T-square, and prepares roughly some parts of a tool (lathe, depthing tool, etc.), which he has to finish later on, when he has acquired sufficient dexterity. As much as possible he is made to do, even from the beginning, work which will be of use to him later on, as it is more encouraging than having to file pieces of iron or brass without ulterior use; also a series of drills and taps, at first much larger than those used in watchmaking—this in order that the student may easily see for himself the correct shape to give to these tools. Practice on the foot lathe, first with the hand graver. The pupil makes a series of screws with shoulders, after a graduated design, adhering as much as possible to the exact dimensions. He next practices on the mandril, turning brass and steel pieces. The attention of the student is here drawn to the extreme importance of the shape and position of the cutter. The sharpening of the cutters is equally the object of similar demonstrations concerning the precautions to be taken so that the cutting edge should always be rigorously maintained in spite of successive sharpenings. The pieces made are always parts of tools which the student finishes when he is able to do so, or of which he delays the finishing until such time as he shall have acquired sufficient ability.

Theory.

Horology.—Preliminary ideas on the divers organs of a watch, their utility and their functions. The first part of the programme is intended to familiarize the pupil with the names of every part of the mechanism and their use, so that before passing to the complete study of all the mechanisms he may have a general idea of them.

Mathematics.—Recapitulation of the arithmetical knowledge the pupil must possess when entering the school.

Mechanics.—Statics, equilibrium of forces, levers, etc.

Drawing.

Exercises in line drawing, geometrical figures, letters.

SECOND PERIOD.

Shopwork.—Making of a rough movement 18 lines. A drawing five times larger than the original is given to the pupil, the graduated marks of which have for base three points placed in a direct line, representing a rough work. This tracing is copied on a brass plate, and the bars on another, out of which they are cut and then filed to shape, the hollows turned, and the screws made. Screw holes are tapped either by hand or on the lathe. This method has replaced advantageously the method of pointing with the caliber used formerly. The caliber is a steel plate pierced wherever the plate of brass is to have a hole. It is applied on the brass disk which is to become the plate of the movement; then the holes for the screws are pointed. This way was found too easy for a school, where the pupil is to learn how to measure exactly, and to know how to transcribe his measurements without any mistakes. The distances are given in tenths of millimeters. They are taken with a compass with movable points made specially for that purpose, and with a

millimeter ruler of the kind used by architects. It is expected that this movement shall be well filed, that the screws shall be carefully made, but the greatest importance is attached to accuracy of measurement. One-tenth of a millimeter larger is tolerated, but it must not be the least smaller. In the case of measures of distance half a tenth only one way or another is permitted. After this movement—which is composed only of the plate, bars, barrel without arbor, and the screws—the pupil makes a second one, 19 lines, for a lever, and proceeds in the same manner, except that in this case screws of commerce are used. He makes a third movement 12 lines; then he finishes a movement of a complicated watch, or else one of an English, American, Spanish, or other caliber.

Theory.

Horology.—Study of the pieces of support, plates, bars; comparative examination of the principal calibers with bars, half plates, three-quarter plates; theory of adjustments, screws, rivets, feet.

Mathematics.—Principles of algebra, equations of the first degree. Elementary geometry having for its object the teaching of the pupil only the most important theorems—which they will have occasions to use in the future.

Elementary mechanics.—Cinématics—Application to mechanics of equations of the first degree, and applications of mechanics to the solution of some problems of bodies in motion.

Drawing.

Drawings in section of pieces of watch work seen from divers sides and laterally. Clean copies made to scale and lightly colored. Designs of movements of various shapes and calibers. These designs differ essentially from what was formerly done and from anything done in similar schools. They must not only represent an object generally, but give the details which are necessary for the execution. They are designs identically the same as those made for the manufacture of machinery; besides which, every drawing must be done in a given number of lessons, and if not finished at the appointed time it is taken away and marked adversely.

THIRD PERIOD.

Keyless mechanism.—Here again the methods used in the execution of the work are different from those formerly practiced. The turning is done on a foot lathe or on a mandrel, the pieces (barrel arbors, keyless wheels, stem-winders, transmission wheels, etc.) being fixed either in American chucks or between centers. Squares are cut in the lathe, and wheels are cut by the students themselves on the wheel-cutting machine. The cutters are selected by the master. Pupils up to this time not having been able to study the theory of depthing or the shape of the teeth, they give their attention solely to learning the practice of wheel cutting so as to obtain regular teeth, well cut and well centered. The polishing of the shoulders and of the rubbing surfaces is done either by hand, by bevel, or by the American wigwag. Polishing of chambers and hollows is done by means of iron disks on the lathe. The pupil thus makes the keyless mechanism for his four rough works, always working from graduated drawing.

Theory.

Horology.—Calculation of wheel trains, connection between velocities and numbers, inquiry into the numbers to be given to wheels and pinions in order to obtain certain velocities.

Keyless mechanism.—Study of the different kinds used, designs and theory of all the pieces of which it is composed.

Mathematics.—Algebra and elementary geometry.

Elementary mechanics.—Dynamic study of forces and of their effect, work, active force, etc.

Drawing.

Designs of keyless mechanisms and of trains. Clean copies to scale of working drawings with flat tints in the sides and shaded.

SECOND YEAR.

FIRST PERIOD.

Shopwork.—Mechanical manufacture of the rough works by the help of machines and processes of the most perfected kind—3 cylinder movements 18 lines; 3 lever movements 19 lines—with their keyless works. During this period the student must give his attention to automatic medical processes. He must learn how, by the ingenious dispositions of tools, one can insure rapidity of manufacture and render the quality of the work done to a great extent independent of the awkwardness of the workman. The professor has again to demonstrate to the student that in many cases, and when the question is only to produce quantities, there is no need for complicated or costly machines, but that simple accessories, easy to make, can render great service. The finishing of the tools commenced in his first year is proceeded with.

Theory.

Horology.—Theory of depths, cycloids, development of circles, conjugated curves.
Mathematics.—Elementary algebra and geometry continued.
Physics and chemistry.—General principles and application of same to horology.

Drawing.

Illustrating the theories of depths, epicycloids.

SECOND PERIOD.

Shopwork.—Finishing train of wheels, the student first makes the train of his 18-line cylinder movement, using bought pinions, the turning of the pinions being done on the pivoting lathe, using shellac. In principle, pivoting on the pivoting lathe and with rouge is the only recognized method in order to obtain perfect work. However, as it is better that the pupils should know several ways of attaining the same object, they are also taught pivoting with the bow, and reducing the pivots to size with the file and burnisher on the Jacot lathe. They finish by the above methods their two 18-line cylinder movements. The pinions for the above movements, as well as for the five preceding ones (total eight), are bought, and for four of them even the pinions and wheels are already riveted, in order that the student shall not pass too much time on train work. The wheels are rounded and the shape given to the teeth by means of wheel cutters. The shape is examined with the eyeglass in a good light, and the pupil must select his wheel cutter until he obtains a shape of teeth coinciding sufficiently with the designs he has made previously.

Since the introduction of the eyeglass with camera lucida, reproducing with the desired enlargement and to scale drawings the teeth of wheels, one can make the student touch with the fingers the imperfections of depths, and by successive corrections obtain wheel teeth almost perfect, especially after they have been made to pass through the Ingold cutter, which gives them an epicycloidal form very difficult to obtain otherwise. Sizes of wheels and pinions are given by the drawings. However, the pupil must learn how to use the proportional compass, which by and by will render him great service, and for that object he is not to use those commercial compasses, more or less corrected and which are always inexact, but a normal compass

accompanied by a table of corrections. For the last two trains, which are the nineteen-line levers, one of them handmade and the other machine made, and both destined for accurate timing, the student must make and cut the pinions. The wheels are no longer divided and then cut to shape, but the shape which they must ultimately have is at once given by the cutter, then they are riveted on the lathe so as to avoid retouching with the wheel cutter, as this always more or less distorts the regularity of the division.

Theory.

Horology.—Horological depths, calculation of tables of correction, construction and usage of the graphics of depths, keyless depths, divers combinations.

Study of the mechanism of complicated watches.

Mathematics.—Principles of trigonometry.

Physics and chemistry continued.

Drawing.

Designs of horological depths, with rounded or elliptical pinions, conical depth, crown depth, keyless depth. Designs of transmission of movements in the mechanism of repeaters.

THIRD YEAR.

It is difficult at the end of the second year to divide the teaching into regular periods, because personal aptitude no longer allows of the uniformity of studies. Students who entered the school at the same time are at the end of two years sensibly distanced from one another, and as at that time they enter into the most difficult part of horological teaching, this becomes more and more accentuated, and the same work can not be expected from them.

Pupils well endowed can undertake complicated mechanisms; for others it would be giving them a task above their capabilities and would prolong indefinitely their stay at the school. Therefore the classification following serves as a base for intelligent pupils, while it is no longer rigorously maintained for others.

FIRST PERIOD.

Shopwork.—Complicated mechanisms. The pupil already possesses a complicated movement in the rough with keyless work and train wheels. The complicated mechanisms he must make from his own drawings. He is given a model movement, but to prevent his copying it servilely he is told to introduce a modification of some sort. Thus, the position of the push piece, of the calender, or some other piece will be changed; or, if a repeater is under consideration, either the general disposition or the times of rest of the striking, etc., will be modified. The pupil is told that when once his drawing is made he will not see the model any more and that he is to take his measures accordingly. Besides, he has already made designs of construction, whereby he has attained a certain degree of proficiency, and if he is at all serious there are no grave interruptions to fear. He makes first of all the detached pieces, and sometimes, when it is a very complicated watch, he is given one or two less advanced pupils to make for him a certain number of pieces from the designs he has worked out.

When all his measurements have been well taken, the assembling of the different parts and the regulating of all the functions do not present great difficulty.

Theory.

Horology.—Theory of complicated watches. Repeaters, descriptions and designs of all details, construction of every mobile, trigonometrical calculations of the dimensions, chronographs, independent center seconds, simple and perpetual calenders.

Cosmography.—Measure of time, movements of the heavenly bodies.
Bookkeeping.

Drawing.

Plans of complicated watches. As in this case the drawings must serve for the execution of the parts in the workshop, it generally happens that the pupil, instead of occupying himself with that task only a few hours a week, fixed by the regulations, gives entire days to that work until it is finished, so as to be able to execute the mechanism without hesitation or stoppage. For the purpose of verification, and before putting into execution, the pupil cuts out in paper every part to the scale of his drawings, then fixes them on a piece of cardboard on which he has previously marked all the places of the mobiles. He can then ascertain at once the errors or omissions which may have occurred during the making of the designs.

SECOND PERIOD.

Shopwork.—Cylinder escapement. After having made a large cylinder (about an inch in length), so that he can see clearly for himself the shape that part is to be, the pupil makes the escapement of four eighteen-line movements, and afterwards another of twelve lines. It happens that for some pupils the transition from eighteen lines to twelve lines is too sharp; in that case they are given in the meantime a movement of fourteen lines. For all these escapements the pupils have to set the jewels themselves.

Theory.

Horology.—Escapement theory. Escapement of clocks of Graham, extension of that escapement to watches becoming a cylinder escapement, trigonometrical tracing and calculation of dimensions.
Cosmography and bookkeeping continued.

Drawing.

Tracing clock and cylinder escapements, designs of construction, drawing of a cylinder escapement complete, with bars, cock, end stones, etc., vertical and horizontal views.

FOURTH YEAR.

FIRST PERIOD.

Shopwork.—Lever escapement. Planting of three lever escapements nineteen lines, the first with covered pallets and four end stones, and the other two with visible pallets and six end stones. The pupil has to make the forks and the jewel settings. Execution of an escapement nineteen lines complete with six end stones and screwed counterweight (fork in the two pieces), cutting of the escape wheel and of the pallets after the trigonometrical measurements made by the student, and inscribed on metal by the method of Grossman's discs. The forms and the dimensions are again verified on the finished escapement by means of a micrometer made to the thousandth of a millimeter, which enables him to measure all distances, the angular lifts, the draws, the rests, the drops, etc. This escapement provided with a first-class balance will subsequently have to be accurately timed, and it is with this object that the best of the nineteen-line movements which the pupil possessed when he got in the escapement class has been kept. He then has to make the escapement of his complicated movement, and finally an escapement of different construction, either English lever, duplex, or chronometer, making altogether eight escapements during his school course.

Theory.

Lever escapement theory, tracings, determinations by trigonometry. Chronometer and duplex escapement, and summary descriptions of some older forms of escapement, little used at present.

Drawing.

Designs of divers lever escapements; plan, horizontal and vertical, of a complete lever escapement with bars, endstones, etc. Drawing of the chronometer escapement.

SECOND PERIOD.

Shopwork.—Examining, casing, and lastly finishing the eleven movements the student has made at school, using the most expeditious means to angle the bars, cross the wheels, etc. The casing of the six movements, machine-made, is done on the interchangeable system.

Theory.

Mathematical theory of timing, study of the balance and balance spring, calculation of the variations in rates produced by the escapement, frictions, faults of the balance spring or balance, etc.

THIRD PERIOD.

Shopwork.—Watch and chronometer timing, fitting of the balance spring, correction of a balance out of truth, or out of poise. Accurate timing in different temperatures and in all positions. The pupil must time at least one of his watches, so as to obtain an A certificate with mention "Very satisfactory."

Theory.

History of horology.

Special teaching.

Repairs of clocks, repairs to watch cases, engraving of letters and monograms, conversions from cylinder to lever escapements. These four specialties are for students who are destined for the watch jobbing trade. Decorative engraving of watch cases, balance making, making of balance springs, cutting, piercing, and finishing of jewels.

When a student leaving school has fulfilled in a distinguished manner the above programme in its entirety, he receives a diploma of merit.

The foregoing programme of the school at Besançon shows how thoroughly the students are educated. The course of studies in other schools vary somewhat according to the requirements of the locality. At the Geneva school five years are required to complete the course of studies. When we see the result of the training in horological schools, in the exhibits at the great expositions, we must come to this conclusion as an absolute fact—to insure our prosperity in the horological art in the future, we must have technical schools on the basis of those in Switzerland and France. In former expositions it was regretted that so few watches had any reliable record of their performance, so that their relative merits could be ascertained accurately. Now, we have observatory certificates of various classes accompanying a very large

number of watches that can be sold at a moderate price. There has been a great improvement in the time-keeping qualities of watches in the past fifteen years, and in the same time the prices have been considerably reduced. The advantages of adjustments in position, isochronism, and temperature are utilized to a greater extent, and scientific skill more appreciated and applied. As the course pursued at astronomical observatories is but little known, we give that at Kew, near London, as it resembles to some extent the others. The trials at the Geneva observatory, we understand, are more exacting.

DETAILS OF TRIALS TO WHICH WATCHES ARE SUBMITTED DURING RATING.

CLASS A.

The trial of a watch entered for a Class A certificate occupies forty-five days, divided into eight periods of five days each and four intermediate and extra days, during which the watch is not rated. First period, watch in vertical position with pendant up at the temperature of the chamber (kept at 60°–65° F.); second period, watch in vertical position with pendant to the right at the same temperature; third period, watch in vertical position with pendant to the left at the same temperature; fourth period, watch with dial up in the refrigerator at a temperature of about 40° F.; fifth period, watch with dial up at a temperature of about 65° F.; sixth period, watch with dial up in the oven at a temperature of 90° F; seventh period, watch in a horizontal position with dial down at a temperature of 65° F.; eighth period, same as the first, watch in vertical position with pendant up. The intermediate and extra days, during which the rate of the watch is not recorded, are at the commencement of the fourth, fifth, sixth, and seventh periods, which are extended one day each for that purpose.

Certificates are granted to watches as follows: To those which have undergone forty-five days test as specified and whose performance is such that, first, the average of the daily departures from the mean rate during the same stage of trial did not exceed two seconds in any one of the eight stages; second, the mean daily rate while in the pendant-up position differed from the mean daily rate in the dial-up position by less than five seconds, and from that while in any other position by less than ten seconds; third, the mean daily rate was affected by change of temperature to an amount less than one-third of a second per 1° F.; fourth, the mean daily rate did not exceed ten seconds while in any position.

The words "especially good" are attached to the certificate when the watch is awarded 80 marks and upward. In a notice of some of the exhibits will be found the observatory rates of a few very remarkable watches, which, by comparison with the foregoing requirements, some

idea can be formed of their wonderful performance in time keeping. The great number, variety, and sizes of watches exhibited, with complicated mechanism, executed and finished with marvelous perfection, such as fly-back chronographs, split seconds, various forms of repeaters, with calendars and moon's phases and also tourbillion watches, excited our most profound admiration. Here was the limit of human skill in the most delicate mechanism at the present time; to take them in detail and note their specific points of excellence would require a volume.

Fly-back chronographs and repeaters, with very bad principles of construction and cheaply made, have been sold to a large extent in this country, and the consequence is that their owners will soon have only the value of the cases for their outlay. Even many of the best class of chronograph watches had a serious fault. They were expected to give accuracy to one-fifth of a second in starting and stopping, but when started the second hand would jump backward or forward sometimes nearly as much as a second; the same fault also occurred when the chronograph was stopped. In fact, we seldom saw a fly back that did not have more or less this fault. Now, it will be found that fly-back chronographs of even moderate pretensions have this fault to a great extent eliminated, thus showing that this system under improved conditions can be used to give accurate results.

In the difficult and laborious task of examining carefully the many exhibits we fully recognize the important services rendered by the foreign judges in this group, Mr. G. M. Rouge, the talented partner of Patek, Philippe & Co., Geneva, and Mr. Charles Emile Tissot, a member of the Swiss National Council, and manufacturer of the highest class of complicated watches at Le Locle. Their high position as the leading exponents of the art in Switzerland gave assurance of good and impartial judgment in their awards to exhibitors. Our social relations were of the most pleasing character and a cheerful remembrance of the Exposition.

UNITED STATES.

The United States Naval Observatory exhibit: At Washington the Naval Observatory is one of the best, if not the best, equipped in the world, and the exhibit here showed to some extent the kind of work that is done there. It has for its object primarily to determine accurately from time to time the positions of the sun, moon, planets, and stars for use in preparing the Nautical Almanac, upon which depends the very possibility of the art of navigation; to test, regulate, and perfect the character of chronometers, upon whose accuracy the naval and merchant marine equally depend in the present age; to issue standard time to the public daily, which time is now needed as a necessity in all parts of the United States for the daily transaction of business, and for the satisfactory working of the time schedules on the

railroads of the country, involving the safety of both life and property in land transportation; to fix accurately the longitude of various places by telegraph for geodetic and other surveys, and to furnish correct time when requested to other branches of the Government and scientific departments; to investigate the subject of magnetism and meteorology, as aids to navigation, and to distribute to vessels of the Navy instruments of precision for navigating purposes.

This exhibit was located in a small building between the Government building and the war ship. It should have had a place in the Government building, where it would have been seen by many more people and to a greater advantage. An astronomical clock made by the Seth Thomas Clock Company was used to obtain the true time for electrical transmission. A small ratchet-toothed wheel was placed on the seconds arbor of the movement between the plates, which opened an electric circuit as each tooth passed a small spring which kept it closed. The fifty-ninth tooth was omitted, so that no signal was given out at this beat. A stud projected from the side of the sixtieth tooth, which acted on another spring, giving a signal at the sixtieth second only. The pendulum had a mercurial compensation, the jar containing about 40 pounds of mercury.

With this clock a chronograph was connected, in which a pen traces a spiral line on a sheet of paper placed on a revolving cylinder, the pen is controlled by an electro magnet, the circuit through which was not continuous but established at every second by the above clock, the magnet at the same time drawing the pen to one side marked the second. By means of this chronograph the time of any observation may be recorded and the beats of clocks compared, even when set up at widely separated stations, and so the difference of longitude between two places established. One such sheet of paper may contain the record of two hours' work. This chronograph is absolutely necessary in recording and transmitting true time, which at Washington is sent over 35,000 miles of wire to 70,000 clocks and 9 time balls.

A display of marine chronometers made by John Bliss & Co. and H. H. Heinrich, of New York, were remarkable productions, showing the high degree of excellence in manufacture attained by these makers, who furnish many chronometers to the Government. A marine chronometer by H. H. Heinrich had a balance with a double rim showing considerable ingenuity in its construction, the effective length of each rim being increased 50 per cent over those in ordinary use. Mr. Heinrich also made a display of the individual pieces of a marine chronometer in different stages of their manufacture, which were very interesting and instructive.

J. S. & J. D. Negus, of New York, and Wm. Bond & Son, of Boston, also exhibited marine chronometers showing excellent workmanship and careful attention to details of construction. An English chro-

nometer by Loseby, purchased by our Government in 1850, has a mercurial auxiliary compensation to the balance. Chronometers with Loseby's auxiliary compensation have had many trials at the Greenwich Observatory in competition with other chronometers and gave remarkable results, but they have not been adopted for general use. The construction of this auxiliary compensation part is too fragile to be relied upon in place of other well-known forms of auxiliary compensation, as the balance carries at the extreme end of each rim a small curved glass thermometer, the bulb of which is fastened to the free end of the rim of the balance, and the stem curving toward the center of the balance.

A marine chronometer made by Domk. Eggert, New York, is the first one of home manufacture purchased by our Government. It was put in use in 1839 and has been in service afloat and ashore for twenty-eight years, and is used at the Observatory for certain purposes.

A chronometer by J. S. & J. D. Negus, No. 1630, saved from the *Jeannette*, was found among their effects where the party perished. It has since made a cruise on the U. S. S. *Omaha*, 1888–1891.

A chronometer by J. S. & J. D. Negus, No. 1366, was found at Newmans Bay, arctic regions, by Captain Nares, of the British arctic expedition. It had been left there by Captain Hall, of the arctic steamer *Polaris*. It was returned to our Government by the British authorities, and the rate papers given with it at the Royal Naval College, Portsmouth, December 3, 1876, showing it was going at the rate of one-tenth of a second per day, losing, being a very slight change from that given when it was issued to the *Polaris* expedition on June 28, 1871, during four years of which interval it was exposed to the inclemency of arctic winters at varying temperatures down to as low as 104° F. below the freezing point, a test unusually severe. Probably no other chronometer has ever been exposed to as great a degree of cold.

J. S. and J. D. Negus, No. 1684: The wheel work of this chronometer is made to break an electric current at the end of each second, and its beats can be registered on a sheet of paper by the usual chronographic register. In this manner it is made use of with a transit instrument to record star transits or register the exact time at which any phenomenon occurs.

The American Waltham Watch Company: The pavilion of this company occupied a prominent location on Columbian avenue, and contained a display that attracted crowds of skilled artisans and admiring sight-seers. Two sides of this exquisitely furnished pavilion were filled by a number of highly finished automatic machines for making parts of watches. The various stages through which the different parts were taken were explained by expert young ladies, who seemed to have their knowledge literally at their fingers' ends, and their lucid explanations were of the greatest interest to all around them. In operation

were a vibrator and accessory instruments for timing hairsprings and balances; a staff machine for making balance staffs completely finished; a pinion-cutting machine operating on eight pinions at the same time; a drilling and tapping machine; a pinion polisher, which is a compound wigwag machine; a machine for squaring barrel arbors; a screw-making machine; a minute pinion machine; a screw-polishing machine; and a demagnetizing apparatus with an alternating electric current. All this complicated and highly finished machinery was automatic, the different movements positive, and the capacity for doing work wonderful. One operator can attend to four machines and accomplish the work of a dozen or more of the most expert workmen by the old methods.

These beautiful machines, constructed with so much ingenuity, so accurately made and highly finished, with their automatic movements so positive and effective, will leave a lasting and elevating impression on the minds of thousands of skilled artisans who will speak of them as the most interesting and wonderful of all the exhibits in the Exposition. To the left, on entering the pavilion, was a handsome model of the factory buildings at Waltham, made to a scale of 1 to 100, occupying a space of about 4 by 10 feet in area. Inside of the pavilion another view of the automatic machines could be obtained, as they were open to inspection on all sides. The product of the factory in 1873 was about 367 movements per day, the product of one day in 1893 by 3,000 operatives, was shown in large glass cases, and consisted of 2,000 movements, from the smallest to the largest, from the cheapest to the most expensive. In a separate case was a line of movements with the upper plate and balance cock made of rock crystal, showing great skill in lapidary work. A watch having the case and upper plate made of rock crystal, and the lower plate of variegated agate with jewels inserted in the usual way was a great novelty. While we were inspecting its skillful construction it suddenly blazed forth with light, showing minutely all its interior construction, producing a remarkable effect; the watch being nearly transparent was suddenly illuminated by an incandescent electric light beneath it, which rather upset our long-fixed ideas in regard to the manner a respectable watch should behave itself. A display of mainsprings, tempered so as to have one side harder than the other, thus imparting peculiar qualities of increased resilient power and elasticity, was of great interest. It is difficult to realize that such a treatment should impart such remarkable qualities to springs, until one sees them coiled one way and then coiled in a reverse direction, when the difference is plainly apparent. An exhibit of watch dials also showed the progress made in their manufacture.

The Breguet form of hairsprings used are constructed by a new method. The last turn of the spring is coiled around a solid core or

"former," upon which the proper shape is given to the overcoil, and then hardened and tempered before being removed from the "former," thus giving to every spring a uniform shape and isochronism that had previously been determined by experiment.

A case of balances showed beautiful workmanship, also an assortment of jewels in intermediate stages of manufacture. A collection of 625 antique watches, belonging to Mr. Evan Roberts, of Manchester, England, showing the progressive improvements made from the beginning of the art, was of exceeding interest. Many of them were once owned by the most eminent and celebrated persons in England during the past three centuries; 12 of them were for more than a century part of the famous Roskell collection in Liverpool. A metal-cased alarm watch that belonged to King James I was made by David Ramsey, London, about 1610. Oliver Cromwell's silver-cased alarm watch was made about 1648 by Bokel, London. John Milton's silver-cased watch, with raised points on the dial by which the blind poet ascertained the time, was made about 1660 by Bouguet, London.

Sir Isaac Newton's astronomical watch, with a shell-enameled case, was made in the seventeenth century by Girod, Paris. King George III, a cyclometer used on his carriage to measure distances traveled, was made by Gout, London. Robert Burns's watch, in three metal cases, was made in 1771 by Fowles, Kilmarnock A silver-cased watch presented by Lord Nelson to Captain Rose was made by Delornie, Paris. Queen Elizabeth's metal and enameled-case watch was made by Jeubi, Paris, in the sixteenth century. William of Orange, a shell-cased watch, silver mounted, was made by Saville, London, 1656. John Calvin's hour-striking watch, in a metal-gilt oval case, was made in the sixteenth century. John Bunyan's watch, with seconds hand on plate, was made by Filter, London, sixteenth century. Lady Jane Grey's silver-cased watch, with enameled dial, was made by Channes, sixteenth century.

The principal makers of London, Paris, Geneva, Vienna, Liverpool, and other cities were represented in the different constructions, which ranged from a watch with a horsehair balance spring and catgut for a chain to those of Ernshaw & Arnold; repeaters, alarms, and musical watches were numerous, and the enamel work on the cases was something very remarkable, as also the magnificent repoussé work on the 22-karat gold cases.

Tiffany & Co.: In the great Tiffany exhibit was a display of 19 watches, 17 and 19 lines, in gold cases, with gold and enameled dials, all in the highest style and finish and variety of design in casing; the casings, with invisible hinges and other artistic work, were particularly remarkable; 5 minute repeaters and 5 five-minute repeaters, 17 to 19 lines; 4 split-second chronographs, and 13 ladies' watches, all showing great care and good principles in their manufacture. Small ladies'

watches, from 8 to 12 lines, had their cases highly decorated with beautiful designs in diamonds, rubies, pearls, and enamels. A watch in the form of a red enameled strawberry, set with diamonds and green enameled leaves, was a gem; one in blue enamel with an urn in diamonds, another in emeralds and pearls, and another a 10-line open-faced, moonstone Cupid and dove with ribbon and flower of diamonds, particularly attracted attention, being exquisite in design and workmanship. A globe clock, supported by a circular temple with twelve columns, was a very interesting piece of mechanism. The globe, about 14 inches in diameter, was made of silver, having on it a map of the world in delicate blue enamel; the equator was a silver band with the twenty-four hours engraved upon it, so that the time at any part of the world could easily be seen; revolving around the globe was a small sphere representing the moon, showing its phases; other arrangements showed the declination of the sun north and south of the equator, and various other astronomical phenomena, all being operated by mechanism in the temple-like base. An astronomical hall clock, showing the relative positions of the sun and moon as seen from the earth, the seasons of the year, positions of the fixed stars, the hours of right ascension of the sun and moon, the tides, etc. A mantle clock, with Westminster chimes, in an ebony case, with Labrador spar dial, and a skeleton clock in a gilt and glass case, with Westminster and Whittington chimes, the open work showing the interior of the movement. An astronomical hall clock in a Louis XV case, standing 8 feet high, had twenty-five silver and enameled dials. On the upper dial the sun and moon were shown in their apparent positions; below, in a line with the horizon, was a representation of the sea, indicating the tides at all hours; then two dials, the right one a perpetual calendar, with the signs of the zodiac, the month, the date of the month, day of the week, leap year, and anno Domini; the other one, on the left, was a disk divided into twenty-four parts (meridian) and degrees east and west from Greenwich. On this dial thirty-one of the principal cities of the world were marked, with the time of day or night indicated by the Roman numerals marked on the main dial outside of the revolving disk at each place. Above these, two small dials indicated the year of Independence and the Julian period; on the main dial were five other dials, indicating, respectively, the equation of time, or difference between the sun and mean time; the chronological cycles, one having the golden numbers and the epact, and the other the dominical letters and sun cycle. The remaining dials showed the local time, Washington time, Greenwich time, the declination by degrees north and south of the sun, and the declination of the moon; one of the wheels governing the latter make one revolution in nineteen years.

H. Conant, Pawtucket, R. I.: This eminent astronomer and mathematician made an exhibit of five very complicated astronomical clocks;

two made by Tiffany & Co. and the others by E. Howard & Co., from calculations and constructions furnished by himself. They were of great interest, particularly so to persons who had some knowledge of astronomy. An isochronal clock, with four pendulums, was a very complicated piece of mechanism, and required a careful examination to understand its working, and must have required a great amount of mental application to bring it to such a state of perfection. A differential clock, showing the difference between solar and sidereal time, the course of the equinoxes, etc., described as follows:

This clock has been in operation more than four years, and is a duplex differential instrument. Duplex, because it is composed of two separate, independent clock movements, each of which will run of itself, as it has a weight and pendulum of its own, whether its fellow is in motion or not. It is differential because the two movements are so connected to a third train that a difference in their rates of speed induces motion in this third train, which records said difference second by second as fast as any is established. The dials are three in number, and are furnished with hands for marking hours, minutes, and seconds. There is a supplementary hand to represent the moon in its mean right ascension. This dial shows at a glance the relative positions of the heavenly bodies, and is really a map of the northern celestial hemisphere. It locates the points of the vernal and autumnal equinoxes, and marks the summer and winter solstices, and always shows the absolute difference between solar and sidereal time, and therefore the constant right ascension of the mean sun.

The other clocks also showed a great amount of labor and thought in inventing their mechanical construction to produce the results required, and all together reflect great credit upon the assiduous, persevering, and gifted astronomer who brought them into existence.

Waterbury Watch Company: The principal attraction in this exhibit was the century clock, which gave movement to a large number of automatic figures as working at their factory in Waterbury; also showing the primitive methods of old-fashioned watchmaking and other industries. The display of this company was very comprehensive, showing fully the duplex Waterbury watch, known all over the world as one of the lowest-priced productions now made to keep approximate time. Their latest productions are superior in quality to those first made, and can be wound in the usual length of time. The output is about 800 watches per day with 500 operatives.

The Ansonia Clock Company: This company claims to be the most extensive manufacturer of clocks in the world. It gives employment to 1,300 people, and its product ranges from the cheapest nickel clocks to the most expensive regulators and artistic timekeepers incased in onyx and gilded bronze. The very large display of clocks showed a great improvement in artistic forms for cases and movements of good quality over those in common use a few years ago, and at such moderate prices that everybody now can have a reliable and artistic timepiece. It was surprising to see how the desire for the beautiful in clock cases has been developed and adapted to movements of moderate

cost within the last ten years, and the price at which they are sold will let them into all markets. The arrangement of this exhibit deserves a special notice, as it was all that could be wished for by anyone desirous of thoroughly examining the different styles and qualities of the goods manufactured by this company. An open court surrounded by little pavilions and high cases containing the different styles of clocks, and a pyramidal display, through the middle of the court, of their most elegant productions, made it one of the most attractive exhibits in the building.

Self-Winding Clock Company: The most conspicuous exhibit of this company was the tower clock in the center of the manufactures building. The tower was 150 feet high, 45 feet square at the base, and beautiful in design and construction. It was furnished with mechanism for striking the hours and quarters and operating the hands on four 7-foot dials, 70 feet high from the floor, and a chime of nine bells weighing over 14,000 pounds. The hammers that struck the bells were raised by "sucking magnets." The large solenoids that surrounded the plungers could be operated by a 110 or a 220 volt current; the electrical contacts necessary were made by the clock and also by an operator at a keyboard. This arrangement was very successful in striking the hours and playing the chimes. The hands were turned by a small electric motor fixed level with the center of the dials and connected with an ordinary open-circuit battery controlled by a relay operated by a master clock situated in the pavilion 150 feet from the tower, by which every minute an electric current was sent to the motor in the clock tower, causing the hands to move forward one minute. The keyboard by which the chimes were played by an operator was also in this pavilion. In the elaborately constructed and beautiful pavilion was a very interesting and complete exhibit of all the apparatus used in the system of the company, such as master clocks, various movements showing the construction and theory of the self-winding and synchronizing apparatus, and a tableful of apparatus used by the Western Union Telegraph Company in sending out the time. Many advantages are claimed for this system, and judging by its successful operation it is all that is claimed for it. The master clock in the pavilion synchronized 200 self-winding clocks throughout the Exposition. The Naval Observatory at Washington furnishes the exact time, and the Western Union Telegraph Company forwards it to every part of the country. Three minutes before noon all general business is stopped and direct communication made with the observatory. Precisely at 12 o'clock a single electric impulse announces the time all the way to the Pacific coast, and as our country is divided into belts of 15°, or one hour each, exact time is furnished to all master clocks without any calculations being necessary. The master clocks then synchronize all the clocks that may be electrically connected with them.

Over 2,600 clocks are thus kept to correct time in Chicago and 15,000 in all parts of the United States.

In self-winding clocks there is an ordinary train from the center wheel to the escapement. Around the center-wheel arbor is a spring about one-fourth of an inch wide and 6 feet long; its inner end is fastened to the arbor and its outer end to a spring barrel, which rotates freely on the arbor and is geared to a motor by an intermediate wheel and pinion. As the center wheel, driven by the unwinding of the spring, makes one revolution it brings up a loose arm carried on the center arbor until it closes the electric circuit; then the action of a little motor rotates the barrel containing the spring one revolution, winding up just as much of the spring as has been required to run the clock during the last hour. This action is repeated every hour. As a result of the frequent winding and reduction of friction it is claimed that the power required to run a clock on this system is only one forty-sixth part of that used in ordinary clocks. Two Leclanche cells furnish the electro-motive force.

Bundy Manufacturing Company, time recorders: In the beautiful pavilion of this company were a large number of clocks for recording a workman's time. On his entering the office he takes a key with his number off a rack, inserts it in the clock, and thus records the time he entered; with the same key he records the time of leaving and replaces the key on the first rack. The system worked in a very satisfactory manner, and no doubt will be very useful in recording the number of hours between the time of his entering and leaving the office. In one corner of the pavilion was suspended in the air a plate of glass about 3 feet square having on it a dial and two hands; the minute and hour hands could be freely whirled around by the attendant's finger, and yet, after a short time, the hands would settle to a position showing the correct time. It excited considerable curiosity and mystified all who saw it. In all probability a watch movement was concealed in the short end of each hand and made so that it would revolve on its center pinion, the end of the pinion being fastened to the hand, the movement in the minute hand making a complete revolution around its center pinion in one hour. In the hour hand the movement would turn completely around its center pinion in twelve hours. At 12 o'clock the heavy side of each movement would be at the extreme end of the short arm of each hand; at quarter past 12 the movement in the minute hand will have turned 90° and the hand will be balanced or in a horizontal position; at half past 12 the heavy side of the movement will be at its nearest point toward the center pivot on which the hands are mounted, and consequently the long end of the hand will be the heaviest and point to half past 12. Thus the movements by the power of their mainsprings will have the position of their center of gravity moved toward and from the pivot on which the hands revolve,

and thus make the hands turn gradually around, keeping approximate time.

The Newman Clock and Manufacturing Company made a large exhibit of clocks specially made for factories, offices, etc., to record the rounds and presence of watchmen at certain localities. They were well made and capable of giving satisfaction in their performance. Small rudely constructed wall clocks with wooden wheels, a crown or escapement wheel, a verge, and a balance consisting of a straight bar with a weight hanging at each end, all made in the simplest manner possible, were quite a curiosity, as they showed how the first clocks with wheels were made, going back nearly a thousand years ago, long before the pendulum was used. They cost but little, very little, and would be an attractive piece of mechanism in any one's house.

H. Muhr's Sons, watch cases: This extensive establishment employs over 600 workmen, and have an average output in gold, gold-filled, silver, and nickel of 5,000 cases per week. In their pavilion about 500 designs in cases were exhibited, and they make them in over 2,000 different styles. They make three grades of cases; 14-karat, warranted for twenty years, 10-karat for fifteen years, rolled plate and raised gold cases with applied work in heavy gold on the outer side. Their good workmanship and careful attention to details, elegant designs with cheapness in price, place them in the front rank in this industry. The stock they use in filled cases was shown having a center of case metal with a plate of gold hard soldered on each side and then rolled into proper shape, showing that the cases were really plate work and not simply heavily gilded.

The Keystone Watch Case Company: This company had an elegant pavilion, furnished in white and gold, near the center of the building. The first attraction was a huge watch of good workmanship 4½ inches wide and 7 inches high, having a solid silver case weighing 5 pounds 7 ounces, containing an 18-size Elgin movement. The display of 14 and 10 karat gold cases, gold-filled cases, silver and nickel cases, was very extensive, showing the complete manner in which all their work is made, and the artistic style adopted in all their different sizes and qualities of cases. Gold-filled cases is an important invention of late years and are used to a great extent. The company claims an output of 2,000 cases per day with 1,750 operatives, and to be the largest watch-case factory in the world. An exhibit of about 60 antique watches was very interesting, showing the various forms, qualities, and styles of workmanship in this art many years ago.

The Ray Watch Case Company: In this exhibit they did not display a full line of goods manufactured by them, but principally to show the perfection to which photominiature work on the inside of watch cases and caps has attained. The photominiatures on the cases exhibited were interesting specimens in this art, showing heads and groups

of prominent and well-known people; in some instances the original photographs and their reproductions on the cases were seen side by side, showing the accuracy of the work. They also exhibited handsomely decorated cases with designs in raised gold, showing good work.

Washburn & Moen Manufacturing Company, Worcester, Mass.: A very extensive exhibit was made by this company of mainsprings for clocks and watches manufactured by their new methods. Prior to 1884 many attempts were made to make mainsprings from rolled wire, but this class of stock was not adopted by any clock manufacturers until 1885. About this time Mr. C. E. Terry, of the Terry Clock Company, Pittsfield, Mass., concluded to adopt it, believing it would make the best spring if properly made up. After many experiments by the Washburn & Moen Manufacturing Company, they, in 1888, started a clock-spring department, engaging with Mr. Terry to build it up. At that time no clock company had adopted this class of springs to any extent, but to-day there is no clock manufacturer in this country but prefers the flat-wire spring to any other, and all have adopted it. The flat-spring plant of the Washburn & Moen Company is the largest in the world, and the amount turned out greater than was ever before produced in one place. These springs have been adopted for every purpose where a clock spring can be used. The manager of one of the largest clock manufactories lately stated that the Washburn & Moen flat-spring wire had made the most complete and successful revolution of anything relating to clocks that he knew of, and that it is astonishing how quickly it was done. In addition to the flat springs, they make all kinds of clock and watch wire, such as clock pinion, pendulum, balance shaft, hairspring, verge, bell, gong, and pallet wire of charcoal and Bessemer grades, in all sizes. Their product of pendulum-spring steel, some of which is one-fourth of an inch wide by only 0.002 of an inch thick, tempered, polished, and bronzed, is pronounced the best ever put upon the market. In our examination we noticed particularly the peculiar fibrous nature and extreme elasticity of the steel after being manufactured.

Nicholson File Company, Providence, R. I.: In the magnificent display of this company was a full line of files specially made for clock and watchmaking, pivot, screw head, burnishing, square, triangular, needle, round, flat, and files specially made for filing up balance wheels—in fact all the different kinds required in this industry. The files are cut by machinery on the increment principle, and their fine 8-inch equaling file requires 424 blows to the inch, which, being doubled, gives about 180,000 tooth points to the square inch of surface and forms probably the finest file ever cut. The excellent quality of these files are widely and favorably known, showing the surprising progress made in this manufacture. The making of such small files is a new industry in this country deserving extensive recognition and support.

SWITZERLAND.

The exhibits from this country were located on Columbian Avenue and displayed in three pavilions. One was occupied by the Genevese manufacturers, another by Patek, Philippe & Co., and the third by the watchmaking centers of Le Locle, Chaux de Fonds, Neuchatel, St. Smier, La Neuveville, Les Bois, La Ferriere, Les Brenets, Bienne, Le Sentier, Renan, and Basel.

Watchmaking commenced in Geneva about the year 1587, but it is claimed that there are two other places where first developed, the mountains of Neuchatel and the Jura Vandois. It has gradually increased and become a national industry, having an annual sale of 6,000,000 watches produced by 50,000 workmen. Their variety in size and design amounts to thousands, comprising all grades and from the smallest gem watch to the most expensively decorated in jewels, inclosing movements so wonderful and complicated in construction that only persons with a thorough knowledge of the art have the capacity to fully appreciate their great merits. Their exquisite designs in casing, jewel incresting, engraving, and enameling are far in advance of any other nation.

While looking over the exhibits we were so impressed with their magnificence, artistic beauty, and great mechanical skill shown, that only an attempt can be made in stereotyped expressions to give some idea of them, for they baffle description, so far does language fail to convey to the mind a knowledge of the beautiful that can only be acquired through the sense of vision. Great attention is given to the accurate performance of their watches, many of them being rated and tested before being sent out to compete with watches of other makers at the various trials at the observatories. It is somewhat a novelty to see a watch selling at a moderate price accompanied by an observatory certificate, but here we had them in abundance.

In regard to their immense progress in the past fifteen years, it will be inquired, How has it been accomplished? Nine watchmaking schools, supplied with the latest chronometrical and mechanical improvements under the teaching of their most expert masters, contribute to the present reputation of their productions. Probably the first of these is the school at Geneva, where a complete course of practical and theoretical instruction extends over five years, to which pupils come from all parts of the world. In connection therewith, a special school has recently been opened where mechanics are practically taught through a course of three years. First year, lower division, work without the aid of machinery; second year, middle division, work with the aid of machinery; third year, upper division, instruments of great precision. Theoretical instruction is given simultaneously in chemistry, physics, technical drawing, and mathematics.

At the observatories in Geneva and Neuchatel the different makers

can have their watches subjected to trials in heat and cold, in different positions, and for isochronism, and are given certificates according to their performance. At the Geneva Observatory a watch to be tested in the highest or first class has to undergo a severe ordeal, and no watch can obtain a certificate unless it faithfully performs in all the stipulated conditions. About two years ago this observatory imposed more severe conditions, and, according to the reports issued by foreign observatories, none can approach the marvelous results now obtained at the Geneva chronometer competitions, and recorded annually in the report of the Geneva Society of Arts. Their horological societies are very active, always discussing and examining any new improvements in the construction of watches, and receive the aid of their commercial and scientific institutions and periodical publications, all combining to advance and perfect their knowledge in this art.

Patek, Philippe & Co.: The productions of this firm, as displayed in all the great expositions, have been of a very high character, always securing the highest awards, receiving at Paris in 1889 the grand prize and other honors. At the Geneva Observatory, in 1893, out of 49 awards to different makers, 20 were given to this firm, who also obtain there every year the first prizes at the yearly timing competitive trials. The use of machinery in making interchangeable and other parts is carried as far as possible, and the most skilled artists are secured to fill the various positions of adjusting, escapement making, jeweling, engraving, enamel painting, case making, and all the other departments where great personal ability is required. All this display has a special, highly artistic character, which could be seen at a glance. This, combined with the best principles of construction, great attention to details, high finish, and accurate performance, has given this firm a richly deserved and world-wide reputation. As Mr. G. M. Rouge, one of the partners in this house, was a member of the international board of judges, this display was, according to custom, "hors concours," and did not appear in the list of awards. In an elegant pavilion was displayed nearly 300 watches and movements, embracing all their calibers from 6 to 20 lines in size. Among them were 4 chronographs, 16 to 19 lines in size; 8 split seconds, 16 to 19 lines; 4 split seconds, repeating hours, quarters, and minutes, with perpetual calendars, 16 to 19 lines; 5 repeating hours and every 5 minutes, 14 to 19 lines; 12 repeating hours, quarters, and minutes, 9 to 19 lines. The 9-line repeater is said to be the smallest minute repeater ever made, a 10-line minute repeater being the smallest exhibited at Paris in 1889. A superbly finished tourbillon, with chronometer escapement and independent seconds with superimposed train, were remarkable productions. An open-face watch, 6 lines in diameter, with lever escapement, was a marvelous chef d'œuvre, showing the extreme limit in smallness that has been attained in this class of watches.

The 6, 7, 8, 9, 10, 11, 12, 13, and 14 line sizes with lever escapements embraced a large number of highly finished watches, having cases decorated with paintings on enamel of great artistic merit, diamonds, rubies, pearls, etc., in such rich and elegant designs that a mere description of them here would fail to convey a correct idea of their great elegance and exquisite workmanship. The chatelaines belonging to the watches were also of the same high character in design and workmanship. The 15, 16, 17, 18, 19, and 20 line watches, in great variety of style and design in movements and cases, could only be fully appreciated after a careful examination of their points of beauty and durability. Eight of these watches had first-class certificates from the Geneva Astronomical Observatory that showed some astonishing performances in keeping time, two of them having gained the first prize at the Geneva Observatory competitive trials in 1892. The observatory certificate for watch No. 91219, a 19-line ancre, gave as follows:

	Average of 5 days.	Sum of errors.
Temperature 14°.88, vertical pendant up	+3s.90	0.4
Temperature. 16°.40, vertical pendant right	+4s.78	1.2
Temperature, 15°.72, vertical pendant left	+ 2.92	0.0
Temperature, 1°.20, horizontal dial up, cold	+ 1.64	2.4
Temperature, 12°.70, horizontal dial up	+ 2.80	2.2
Temperature, 33°.14, horizontal dial up, heat	+ 1.84	1.2
Temperature, 12°.42, horizontal dial down	+ 3.64	.8
Temperature, 12°.84, vertical pendant up	+ 3.94	.6

Mean variation of daily rate ±0s.22, compensation variation for 1° C. ±0s.04, all of which is certainly a wonderful performance. A 17-line watch repeating the hours, quarters, and minutes with pusher on the pendant, metal bell, gold antique open-face case, chased and repoussé, double gold case representing the Elopement of Europa, from a picture by S. Le Clerc, was a remarkable production. A very curious and interesting exhibit of 17 antique watches from the collection of Mr. Amerigo Ponti was in the front case. Among them was a movement in the shape of a cross inclosed in a crystal case. It had a fusee and chain, but no hairspring or regulator, and was running. This beautiful piece of mechanism was made by Jean Rousseau, great grandfather of the famous philosopher, born 1606, died 1684, and is mentioned in his will of May 13, 1684. Another watch with a balance and hairspring in a tulip-shaped case, the sides being crystal, by the same maker, was constructed during the latter part of his life. A large watch with striking mechanism, "Nuremberg Egg," without hairspring, being regulated by means of pins, fusee with a string in place of a chain, date about 1550, was a great curiosity. A frame suspended in the pavilion contained 19 gold, 30 silver, and 16 bronze medals, decorations of the Legion of Honor and from the Pope, that received awards for the excellence of their manufacture.

Paul D. Nardin, Locle: A watch very remarkable in appearance, that was awarded the grand prize at Paris in 1889, first attracts attention in this exhibit. It had a double case, the inside one being gold and the outer one of oxidized silver, containing a very high grade 20-line movement, repeater, split seconds, minute register, with a first-class certificate from the Neuchatel Observatory. It was too large to be carried, being 4½ inches high by 3 inches broad and designed for a presentation or souvenir watch. The art work on the outside of the case was bold and grand in design and execution. On one side of the case were two figures. Fame crowning Labor; on the other side a representation of the industrial arts, with a bust of Minerva. The side scrolls were surmounted by tigers' heads, and above these two infant boys, all executed by chisel work in bas-relief and valued at $2,000. Two superb marine chronometers elegantly cased, having a daily variation of ± 0ˢ.11 and ± 0ˢ.14, respectively, show the remarkable degree of perfection that has been attained in this important industry by this house. One of these is intended to be used with a pen chronograph, to register seconds by electricity, the chronometer being constructed so as to make electrical contacts every second. In a report of the Neuchatel Observatory we find that in a trial of 12 chronometers of this kind the mean difference between their general daily rates and that shown by them when establishing an electric current every second was only 0ˢ.22, and for several of them the difference was imperceptible. A remarkably successful solution of this problem in mechanics. An improvement in winding chronometers, by which they can be wound without turning them over and winding through the back, is also of importance. Two tourbillon watches, having a new winding system, were superb specimens of the finest workmanship. A collection of about two dozen watches with observatory certificates, comprising repeaters of all kinds, split seconds with minute registers, and perpetual calendars, and also plain time watches, were of the highest class in manufacture, and reflect great honor upon this house.

A. Golay-Leresche & fils, Geneva: In the front case of the Geneva pavilion was a display of about 300 of their most expensive, complicated, and highly finished watches, comprising repeaters of all kinds, split seconds, chronographs, independent seconds, and their various combinations; tiny watches as small as 6 lines, in cases of many fanciful designs, decorated all over with precious stones, painted enamels, and engraving. It would be a difficult task to enumerate the great merits of each individual piece and draw conclusions as to their relative merits, as all seemed so perfect in design, beauty, and mechanical excellence, sustaining fully the reputation this house has had for the past fifty years for the excellence of their productions, as attested by the many medals they have received from the great expositions. A

small musical casket with a little watch in front, and decorated with exquisite workmanship, was a surprising wonder. On touching a spring its cover would suddenly open and a little singer with the brilliant plumage of a humming bird would fly up, warble forth its exquisite song with twittering bills and fluttering wings, as if it were truly a living bird; then it would quickly disappear, and the cover automatically close the casket. Value, $1,700. A lily about 3 inches long, incrusted all over with diamonds, would, when its center was touched, fall apart and disclose a wee watch. An old silver casket, having on its sides a timepiece and five enamel paintings of great merit, representing "Courtship," "Engagement," and "Marriage," was a superb piece of art work, valued at $1,300. Prize medals at Berne, 1857; London, 1851 and 1862; Melbourne, 1880; Paris, 1855, 1878, and 1889.

E. Wirth, Geneva, made a display of complicated watches of exceeding merit, such as repeaters of all kinds, fly-back split seconds, chronographs, independent seconds, and their various combinations; chronometers with Geneva Observatory certificates, also watches with the most artistic decorations in diamonds, pearls, rubies, and enamel paintings on the smallest of fanciful cases. This is the old house of Doufour & Co., who received the highest awards at Vienna, 1873; Paris, 1878; Melbourne, 1881; and was "hors concours" at Paris, 1889, one of the firm being vice-president of the jury. They also received the third prize at the Concours de Reglage in 1892.

L. Bachman, Geneva, successor to Fritz, Piquet & Bachman, made a very comprehensive exhibit of over 90 watches, many of them having first-class certificates from the Geneva Observatory. Specially noticeable were a lever watch with 42 jewels, split seconds, fly back, and minute recorder; a lever watch with 36 jewels, minute repeater, fly back, and split seconds, that took the prize at Geneva in 1890, and a 31-jeweled lever, quarter repeater, with perpetual calendar. Then followed an extensive line of repeaters, quarter and split seconds, fly backs, astronomical and calendar watches, and very small watches in flowers, insects, and fanciful cases, decorated with diamonds, rubies, sapphires, pearls, etc., in the most exquisite designs; also chatelaines of remarkable workmanship, designed in the style of the watches they belonged to. Watches of great precision, and the various combinations of repeaters, split seconds, perpetual calendars, etc., are a special manufacture by this house. The following record taken from an observatory certificate will show the accurate performance of one of his watches: Pendant up, 5s.38; pendant right, 5s.50; pendant left, 3s.02; dial up, 5s.24; dial down, 5s.60; pendant up, 5s.02. Silver medal at Paris, 1876; gold medal, Melbourne, 1880; diploma of honor, Zurich, 1885; gold medal, Antwerp, 1885.

Alcide Baume, Le Bois: This exhibit, although small in number, was great in merit, showing the wonderful degree to which watches have been perfected in correct timekeeping. A gold "tourbillon" chronometer, No. 103018, had a class A certificate from the Royal Observatory at Kew, England, giving it 91.9 marks out of a maximum of 100, and the indorsement "especially good." Its performance is claimed to be the nearest to perfection ever yet attained by any watch, it having received the highest award ever granted by this observatory. According to the certificate, its performance under the different conditions to which it was subjected was as follows: Mean daily rate, pendant up, 0ˢ.8; pendant right, 0ˢ.6; pendant left, 0ˢ.7; dial up, 0ˢ.4; dial down, 0ˢ.2; mean variation of daily rate, 0ˢ.26; mean change of rate for 1° F., 0ˢ.03; difference between extreme gaining and losing rates, 2ˢ.5; marks awarded for daily variation of rate, 34.8; for change of rate with change of position, 39.3; for temperature compensation, 17.8; total, 91.9. A watch similar to the above had a class A Kew certificate with 87.5 marks and indorsed "especially good." An hour, quarter, and minute repeater, split second, and minute-recording chronograph, had a class A certificate with 70.2 marks. A highly finished movement with a class A certificate had 81 marks. A split second, minute-recording chronograph and a gold minute repeater were also of high-class manufacture; also a variety of other movements, some with class A certificates. Baume & Co. have held the first position for complicated watches at the Kew Observatory since 1887, with a split second, minute-recording chronograph which was awarded 85.1 marks and the indorsement "especially good." Up to the present time this has not been surpassed. This house has received medals awarded for excellence of manufacture at all expositions in which they participated. The general construction, finish, and performance of these watches is very creditable and deserves the attention of all who appreciate superior excellence in timekeeping.

Jules Alfred Jürgensen, Locle: The watches of this exhibit are of the Jules Jürgensen, Copenhagen, type of manufacture so well known for the past fifty years, and now continued by his son at Locle. Ten-minute repeaters are a new construction by this house; being the first of this class ever made they attracted considerable attention as something unique. A twenty-four hour watch called "Cosmopolitan," had two sets of hands, one set making a revolution in twelve hours and the other in twenty-four hours. There were 32 watches with observatory certificates, comprising plain lever, chronometers, repeaters, chronograph with one-fifth second fly backs, split seconds with minute register, and seconds with fifths of a second hand on same axis, all showing that excellence with which this name has so long been associated. We noticed that the long lever so characteristic of this watch from its introduction is still retained.

Zentler frères, Geneva: This firm made a grand exhibit of complicated watches, such as minute repeaters, fly-back split seconds, chronographs and their complications, chronometers with certificates from the Geneva Observatory, chatelaine watches, watches in finger rings, and other fancifully designed cases, all highly decorated and incrusted with diamonds, rubies, pearls, and painted enamels. The most attractive was a 10-line lever with the dial partly surrounded by a crescent of diamonds and a crescent of rubies; on the case was a Macaw formed of diamonds, with ruby eyes, and gold feet and beak. A beautiful scroll of diamonds and rubies formed the pin, and a chain suspending the watch had alternate links of diamonds and rubies. A hairpin in which a small watch movement caused a large diamond star to revolve was a gorgeous piece of work. They were awarded at Vienna, 1873, a medal for merit; Paris, 1878, a silver medal; Paris, 1889, a gold medal; Geneva Astronomical Observatory, 23 medals, 4 of which were first prizes; National Academy at Paris, 1884, a gold medal, and in 1890 diploma of honor; also at Paris, 1878 and 1889; Melbourne, 1881, and Zurich, 1883.

Ernest Francillon & Co., St. Imier: With this firm we have another grand prize at Paris in 1889, also a large number of medals attesting to the excellence of their productions. They have had for a long time a world-wide reputation with their "Longines" watches, which have given such general satisfaction at a moderate price. They use automatic machinery to a large extent in their factory, leaving only the escapement to be made by hand, making their own cases in gold, silver, oxidized silver, oxidized steel, and enamels, decorated with precious stones. They are prominent among the most progressive manufacturers of Switzerland, and their products go everywhere. Their exhibit of 16 and 18 line movements deserves much praise, and 2 large gold watches bearing in colored enamels the coats of arms of the Republic of Mexico, and the Argentine Republic, show their skill in this kind of work.

Eugène Clémence-Beurret, Chaux-de-Fonds, made a great display of exceedingly small watches in bracelets, in the form of swans, padlocks, beetles, butterflies, and globes incrusted with diamonds, rubies, pearls, and enamels, in the most artistic manner. A large number of repeaters, split seconds with calendars, chronographs, and their combinations, plain time watches of all sizes and excellent manufacture, with cases decorated in the highest style of the art, altogether making a gorgeous and highly meritorious collection.

Maurice Ditisheim, Chaux-de-Fonds: An immense watch about 40 lines in diameter, with an exquisitely painted Limoges enameled dial, made by Alfred Meyer, was a very novel production. The painting represented Venus crowning Saturn, the case being made of oxidized steel. A magnificent display of all kinds of repeaters, some automatically

striking the hours in passing, split seconds, fly backs with calendars and minute registers, watches from 12 to 20 lines with observatory certificates, and also watches with automatic mechanical figures. A large number of the most beautiful gem watches from 6 to 14 lines, having lever and cylinder escapements and cases of the most unique designs, profusely and artistically decorated with diamonds, rubies, sapphires, pearls, and painted enamels, were a great attraction.

Piquet, Guillaume & Co., Le Sentier, made a small but very interesting display of 5 of their superb, complicated watches of the highest grade, such as a 17-line watch with a quarter-seconds recorder, split seconds and minute recorder, and minute repeater. In their new system the split seconds is isolated, so that it may not load the mechanism when not in action. They are the sole makers of Piquet's split and the lightning 4th and 5th split second and minute recorder, for which they claim great merit. A 10-line split seconds and one-fourth second was an exquisite piece of work; also other combinations of repeaters striking automatically the hours in passing, perpetual calendars, split seconds, and recorders.

Boré & Courvoisier, Neuchatel: In this exhibit were 65 watches ranging from 10 to 20 lines in size, 18-line and 10-line movements being a special manufacture, many of these having certificates from the observatory at Neuchatel; repeaters automatically striking the hours in passing, chronographs, calendar, and plain watches, a number of chatelaine and other tiny watches, with cases beautifully decorated. A bronze medal from London, 1862; a bronze medal from Philadelphia, 1876; a gold medal from Paris, 1878, and a silver medal from Chaux-de-Fonds, 1881, gave assurance of the high character of their manufacture.

H. Redard & fils, Geneva: This house, founded in 1844, made a magnificent display of 50 watches of excellent quality, comprising repeaters of all kinds, split seconds, fly backs with and without perpetual calendars, first-class watches with lever escapements, chronographs with minute recorder, and a large number of small watches in fanciful cases and bracelets, decorated with diamonds, rubies, sapphires, pearls, and painted enamels in the most exquisite styles attainable in the art.

Jacoby & Co., Geneva, exhibited a collection of chronometers, hour, quarter, and minute repeaters, chronographs, lever watches of the best quality with first-class observatory certificates, sweep-second watches and ladies' watches in great variety in bracelets and fancy cases, also nonmagnetic watches for general use.

Paul Matthey-Doret, Locle: With all the watches made by this house certificates of their rates of running are given, the trade-mark is "Maisonette." Something new in the way of an intermittent striking arrangement was shown in a repeater, where the quarters striking

can be switched off. A 13-line repeater with elegant work, a chronograph with one-fourth of a second hand, a repeater automatically striking the hours in passing, and a number of large and small watches of excellent construction and finish, were deserving of much praise.

C. Degallier, Geneva: A magnificent collection of chatelaine and bijou watches, small watches in bracelets, tiny globes, and other fanciful designs, all highly decorated with diamonds, rubies, sapphires, pearls, and painted enamels in the most excellent workmanship, watches of the highest quality with first-class observatory certificates, repeaters, split second, fly backs, and other complicated watches, all showing first-class workmanship.

Marius Lecoultre, Geneva: In this exhibit were highly decorated watches of great beauty with painted enamels, diamonds, rubies, and pearls; chatelaine watches in the form of globes and other fanciful designs, bracelets inclosing the smallest of watch movements; repeaters of various constructions, split seconds, and a line of first-quality lever watches. A special caliber of this maker has an independent center-seconds provided with a double train which can be converted into a fly-back chronograph. It is called an independent-seconds chronograph and might be used to a great advantage in timing the speed of horses. All this display fully sustains the reputation of this house for the past fifty years for excellence of manufacture in productions of the highest grades.

Louis Rozat, Chaux de Fonds: This house made a display of eight-day watches, repeaters that strike automatically the hours in passing and at will, chronographs with minute register, repeaters with chronograph and minute register, and plain watches; also very small watches, from 8 to 13 lines, with fanciful cases artistically and richly decorated with diamonds, enamels, and pearls. Having obtained twelve consecutive Kew Observatory (class A) certificates is a guaranty of the time-keeping qualities of his productions.

Droz-Jeannot fils, Brenets: In this exhibit were tourbillon watches with fine chronometer escapements; fine chronometer movements with first-class certificates from the Neuchatel Observatory; a line of movements to fit American cases. Their movements were well jeweled, having a jeweled barrel and an arrangement to prevent overwinding; a number of sweep seconds, and other finely jeweled watches, showing the excellent quality of their productions. They are the patentees of a "jeweled stem-winding mechanism," which they showed in several movements.

Z. Penenoud & fils, Chaux de Fonds: This was a collection of 18 exquisite gem watches, from 8 to 13 lines in size, with cases in different styles, highly decorated with designs in diamonds, rubies, pearls, and enamels; also watches very large in size, running eight days, all showing exceedingly fine workmanship and good principles of construction.

Gindrat-Delachaux, Chaux de Fonds, make a specialty of calendar watches, showing the day of the week, of the month, and phases of the moon through openings in the dial. Fifty watches, in 16, 17, and 18 line sizes, showed the various grades characteristic of their manufacture.

Arthur Graizely, La Ferriere, made an exhibit of 72 eight-day watches in all styles and sizes. The lower part of the dials were cut away, showing the movements of the balance. They are a specialty with this house, and were very attractive.

G. Jeanneret & E. Vrocher, Chaux de Fonds: This was a remarkable exhibit of complicated watches of all combinations, with observatory certificates of their performance. A 14-line minute repeater, chiming every quarter hour, was a gem in horology; a 20-line minute repeater, with chronograph and perpetual calendar, chimed every quarter hour; a 20-line minute repeater, with automantons, watches in very small globes, and a number of very small bijou watches, decorated with enamels and pearls, all showing extraordinary skill and talent in this difficult kind of work.

P. Prunner-Gabus, Locle, exhibited a 20-line watch with chronometer escapement, and having 53 ruby and 2 sapphire jewels. All the screws in the bridges and pillow plate, and screws for the jewels, were capped with rubies. This work gave rather a pretentious appearance to the movement, but showed the extent to which the skill of a lapidary can go. The first impression was that the whole screw was made of a ruby, thread and all, but upon a close inspection it could be seen that the rubies were coverings cemented on the heads of ordinary screws.

Albert Jeanneret & frères, St. Imier: In this display a beautifully engraved case had on one side the arms of the United States in colored enamel, and an oxidized silver case with gold lions rampant, bearing between them a shield, were highly artistic pieces of work; a large number of watches of various grades and constructions, from the cheapest to the most expensive, from the smallest to the largest, and a line of lever watches showed good workmanship.

Weill & Co., Chaux de Fonds, showed 37 watches, embracing split seconds and other complicated mechanisms, some of them having seven small dials about the size of an ordinary seconds dial painted on a large dial, so as to show the time at London, Paris, St. Petersburg, Chicago, Washington, Calcutta, and San Francisco. The work was well made, and their constructions will give satisfaction to their customers.

Ch. Couleru-Meuri, Chaux de Fonds, made a display of 38 calendar watches, having dials elaborately ornamented with colored enamels, the most of them 18 lines, cased in silver and oxidized steel, to be sold at a low price, also 3 very large watches, 36 lines, about 3 inches in diameter. A very useful watch for the blind was shown. It had but one hand and a nickel dial, and had 12 projecting pins, one at each

hour. At a particular hour a corresponding pin would drop and the hour known by the absence of a pin.

Wuilleumier frères, Renan, exhibited self-winding watches in great variety, cased in gold and silver. They were wound up by the act of walking about fifteen minutes. They were constructed on the well-known pedometer principle, invented more than a hundred years ago, but now their manufacture being revived they are quite a novelty.

Fritz Chatelain, Neuchatel, manufactures watch cases that contain pedometers. They can be carried in the vest pocket, and by means of his patent regulating wheel record the exact distance, it is claimed, traveled when walking. They appear to be well made and will approximate exactness in their performances.

Albert Ditisheim & frères, St. Imier, made an exhibit of gold and silver 18-line lever watches with calendar and moon's phases; also 14 and 16 line watches and chronographs, all well made.

Droz & Co., St. Imier, displayed large and small watches, some with sweep seconds, all good work. They received silver medals at Paris 1889, Antwerp 1885, Amsterdam 1883, Chaux de Fonds 1881, Paris 1878.

Fr. Vilingelfuss, Basil, exhibited watchmen time detectors that were well made and capable of rendering good and efficient service.

F. Borgel, Geneva, had something new in his waterproof cases made in a single piece without hinges; many of them were made of oxidized steel inlaid with gold. A number of the smallest watches made, beautifully decorated with diamonds and enamels, in small globes, bracelets, and chatelaines were very attractive and showed great skill in this most delicate department of watchmaking.

J. Ferrero, Geneva: A 7-line watch with its back entirely covered with a single diamond valued at $1,300 was a very unique production. It was truly brilliant all over, and attracted general attention by its wonderful beauty. A large number of exquisitely ornamented cases in enamels with portraits and landscapes showed artistic work of the highest grade, and fanciful cases incrusted and decorated with magnificent designs in diamonds, rubies, pearls, and enamels made a grand display.

Fred-Julien Sagne, La Neuveville: Conspicuous in this display was a large lever watch, fully jeweled with very large jewels, the screw heads being capped with jewels, making it a very showy and expensive movement. Minute repeaters, split seconds, chronographs, calendars, and plain watches with observatory certificates were all of good construction and finish.

A. Glaton, Geneva: This was a collection of the very smallest watches, having cases most elaborately decorated with exquisite designs in diamonds, rubies, sapphires, pearls. and enamels, showing great talent and skill in this most difficult kind of work.

Ch. Dufaux, Geneva, is celebrated for his most exquisitely made balance springs of steel and palladium. Here 48 of them were arranged in the form of an immense balance spring. All the forms, from the smallest to the largest, of flat spiral, helical or cylindrical, globular, and double cone, made with the highest degree of skill and care, were arranged in elegant designs. Twenty medals attest to the great merit of his manufacture.

Ulysse Perret, Renan, had a complete line of mainsprings of all kinds and sizes displayed in the design of a lyre, his trade-mark. His springs are made in precise metrical lengths, needing no fitting by a workman. His invention of a stay clasp spring in one piece does away with other methods using an additional piece. This house claims to be the only maker in Switzerland employing steam power and mechanical processes in making mainsprings. None but skilled labor is employed, using stock possessing all the required qualities of elasticity, strength, and regularity. All of his productions are of the first class in quality. regularity, and finish. Was awarded a medal at Paris, 1889.

C. & E. Leisenheimer, Geneva, displayed mainsprings, from the smallest to the largest, of excellent quality, showing great care and skillful workmanship in regard to elasticity, strength, and regularity in thickness and width.

A. Herzog, Geneva, made an elegant display of mainsprings of all sizes and forms, of the best quality, and highly finished work, arranged in designs of a lyre, and a clock and a compass, dials with letters and figures formed of many small, tightly coiled springs. This house was established in 1840, and it is stated that out of 48 watches admitted to the Geneva Observatory trials in 1892, 40 had Herzog springs. He has been awarded prizes at Paris, London, Philadelphia, Vienna, Lyons, and Zurich.

C. A. Milliet, Geneva, exhibited mainsprings of all sizes, in elegant designs, showing the great skill and care used by this maker in all the details required in making such perfect productions.

Chr. Schweingruber, St. Imier: This display of mainsprings and hairsprings of all sizes was arranged in beautiful designs, and showed the degree of perfection arrived at in the quality of his productions. This house, established in 1866, has a yearly output of 180,000 dozens of mainsprings, made by 80 workmen.

Boulanger, Maillard & Co., Geneva, made a beautiful display of watch dials enameled by the B. V. J. process, variously decorated dials in underglaze enamels of a superior quality, plain dials, and for chronographs and calendars, all showing accurate work.

Moré & Méroz, Geneva: This display was of dials of the greatest excellence, showing execution of the highest order in the art. Enameled dials with exquisitely applied raised gold were something splendid.

They have medals from expositions at Paris, Philadelphia, London, Vienna, Melbourne, Berne, Zurich, and Besançon.

J. Wyss fils, Chaux de Fonds, made a grand exhibit of enameled dials in novel styles and designs, embracing underglaze, ivory, and transparent dials of all colors, and the finest quality of plain work. This art appears to be about as near perfection as the requirements of the trade demand. There seems to be a tendency to overdecoration with colors, which may be attractive to some buyers, but it gives the impression to people of good taste that the dials cover movements of inferior quality.

Grobet frères, Vallorbes: In a very large wall case were displayed in various designs files of all kinds, from 1 inch to 2 feet in length, of every required shape, and for special purposes. They are the largest manufacturers of files in Switzerland, were established in 1834, and their reputation for making files and gravers of the highest excellence is worldwide.

Vautier & fils, Geneva: Everyone who has handled files and gravers is familiar with this stamp. Their exhibit in an upright case embraced in artistic designs all the known forms of files and gravers from the smallest to the largest used in watch making, and the large number of medals awarded to them by the great expositions shows the great merit of their productions.

J.-Marc Servet, Geneva: A very fine and tastefully arranged display in an upright case of a complete assortment of files of all shapes and kinds for watchmakers' use was very attractive, and showed the excellence of his manufacture, which is attested by a large number of medals awarded for their merit.

Borloz & Noguet-Borloz, Vallorbes: In a wall case about 50 square feet of surface was covered, in handsome designs, with files of all shapes, sizes, and fineness of cutting, expressly adapted to all the wants of clock and watch makers. Something new was shown in small files for the most delicate use. They were not cut, but their abrasive surfaces were so prepared as to show a very fine grain, which in some kinds of work would be very convenient, as they leave a kind of finished surface.

L.-E. Junod, Lucens, had a very extensive and interesting exhibit of jewels for watches and chronometers, hole jewels, cap jewels, jewels for duplex, chronometer, and other escapements, all made in the most perfect manner possible in the art. As many of them were microscopic in character, but few people could appreciate the wonderful skill displayed in their manufacture.

Wagnon frères, Geneva: Arranged in many elegant designs were exhibited the most exquisite and delicate watch hands possible to be made—gold, silver, steel, oxidized and jeweled—and their combinations from the very smallest second hand to the largest used in split

seconds. The many beautiful forms, accurate workmanship, and artistic skill shown in their construction were a source of wonder. Few people are aware of the great difference in the quality of watch hands. They stamp the quality of the watch. As soon as an expert looks at the hands and dial he knows in advance the grade of movement he will see when the case is opened.

Richardet, Chaux de Fonds, manufacturer of watch hands of all descriptions, made a very creditable display of this most delicate work, beautifully made in form and finish, suitable for all kinds of watches.

P. Guye & Co., Geneva: Arranged in beautiful designs were balance springs for watches, of all sizes, from the smallest, which could only be appreciated by being seen under a microscope, to the largest used. Little is known of the extremely delicate touch and skill required to place the smallest of these properly in a watch. Placed on a piece of white paper, one intended for a six-line watch would look to an ordinary person like a dark speck or stain, and to place one of this size properly in a watch costs $20.

Bartimi & Co., Bienne, made a large display of exquisitely made balance springs, from the smallest to the largest sizes in the different forms used—cylindrical, spiral, globular, etc. In late years there has been a marvelous improvement in this industry, particularly in the exquisite finish on all sides given to the springs, which, from their delicate construction, would seem almost an impossibility.

Tschumi fils, Geneva, made a display of their admirable work in brushes specially made for watch and clock makers. This branch of brush making requires particular care and skill, which was shown in their meritorious work.

GERMANY.

From this country there were 44 exhibits in this group. In the watch-making industry there has been a remarkable improvement. Their two exhibits showed progress in the high grade of complicated watches which have only in late years been put upon the market, showing that a technical education in horological schools is bringing forth more skillful artisans.

The clock industry also has made progress in more artistically designed and constructed cases, as well as movements. The products of the Black Forest district were shown by many makers, and a noted improvement in their workmanship since their display at Vienna in 1873 was plainly to be seen. In some of the work of their best makers an approach to the finest class of French manufacture was apparent, and the efforts in new principles of construction give evidence that their brains are actively at work in invention. Wall clocks, mantel clocks, and hall clocks, from the most elaborate and costly in design

and execution to the cheapest grades, were a very fair exhibit of the state of the art and the character of their products.

Dürrstein & Co., Dresden: This exhibit of the characteristic Glashuette manufacture comprised plain and complicated watches in cases of different designs and sizes; one specially grand was marked sold at 5,000 marks (about $1,250). It was a minute repeater, with four small dials on the large one, self-striking as it passed each hour, split seconds and fifths of a second, perpetual calendar, moon's phases, two secondhands on the same axis, one showing fifths of a second and going around sixty times in a minute, while the other made one revolution in a minute. The fifths of a secondhand could be stopped, and is a flyback. All the ten hands can be set without opening the case. Also showed self-striking and minute and quarter striking repeaters, chronographs, and well-constructed time watches made after the Glashuette caliber; watches with projecting pins at the hours made specially for the blind; cases with designs in colored gold; monograms in silver and yellow gold; also decorated with diamonds, enamels, paintings, engravings, and repoussé work.

A. Lange & Söhne, Glashuette, have made an advance on their usual manufacture of twenty years ago in producing complicated watches, such as split seconds, repeaters, etc., all good work, and upon new principles of construction. The individual parts of their watches were shown, so that they could be thoroughly examined. An appatus for ascertaining the compensating power of balances in heat and cold was a very ingenious construction and extremely delicate in its performance. Their exhibit of plain watches, for which they have had a wide reputation for many years, had their usual careful workmanship to insure good time-keeping qualities. A split-seconds and minute repeater, with calendar and moon's phases, with a certificate from the Leipzig Observatory, valued at $1,200, was an admirable piece of work. A quarter repeater, with improved construction in winding work, and a tourbillion with chronometer escapement, were beautiful and artistic constructions; quarter and minute repeaters of excellent workmanship. A calendar watch wound up by the act of walking, and also wound and set by the pendant, was a new production; also ladies' watches in different styles. Their case contained many medals awarded to them at the great expositions.

Gustav Speckhardt, Mogeldorf: In the German Government building was a large clock, 16½ feet high, containing 13 large clock movements to give motion to its different parts, 2 for the time and striking hours and quarters, 1 for making music, 1 for the clock, and the others for giving motion to the groups and single figures. The cock crows morning and evening, an angel with a hammer strikes the hours, and Death, with a bone, the quarters, followed by a chiming of bells. A group of figures comes on the stage each hour and play

music suitable to the scenes to be enacted—the entrance of Christ into Jerusalem, the Last Supper, the scene at the Mount of Olives, the Scourging, Christ before Pilate, the Way to the Cross, the Crucifixion, and the Resurrection. The case was ornamented with rich carvings and many figures of persons in the Old and New Testaments, altogether showing an immense amount of patience and ingenuity in its construction.

Bavarian Ludwig pavilion: In this pavilion was a large bronze elk supporting a square tower containing a clock on his back; on the case at each of its four corners were mermaids, and on the side of the elk hunting implements. This remarkable work of art was designed by F. Gedon, of Munich. A table about 5 feet high, having legs carved with highly artistic designs, supported a richly carved square-cased clock; each side of the square contained a large dial; one of the dials had on it smaller dials, showing the month, day of the month, day of the week, and moon's phases; another dial had seven smaller dials showing the time in seven of the principal cities of the world; another side was occupied entirely with one dial having two hands to show the time. The movement was made by R. Korfhage.

Sigmund Riefler, Munich, exhibited an absolutely free pendulum escapement, with impelling action in the axis of oscillation; a mercurial compensation pendulum, and an astronomical clock fitted with the escapement and pendulum. A small turret clock of beautiful workmanship in which the escapement could be seen and its action understood was also exhibited. From the advantages that he claims, and a certificate of its remarkable performance from the Royal Observatory at Munich, it is deserving of much consideration. The rod of the pendulum is made of a steel tube with a bore of 16 millimeters; thickness of its walls, 1 millimeter, filled with mercury about two-thirds of its length; the metal bob, weighing several pounds, is lenticular in shape. The pendulum is kept in motion by an ingenious escapement that moves the point of suspension at every beat, so that it is claimed to be an "absolutely free" pendulum.

At the Vienna Exposition, in the exhibit of Samuel Kralik, of Pesth, was a regulator with two glass tubes containing mercury for a pendulum. The tubes vibrated upon a knife-edge adjusted about 6 inches below the top of the mercurial columns. In the exhibit of Guilmet, of Paris, was a clock that had a female figure standing on the top of it with an arm extended upward holding suspended by her fingers a pendulum; by an imperceptible rotary movement to and fro of the base on which the figure stood, caused by the escapement, the point of suspension of the pendulum was moved at every beat, and consequently the pendulum continued in vibration, much to the wonder of the lookers-on. So we had an "absolutely free" pendulum and compensation by mercury in tubes composing the pendulum more than

twenty years ago. How far the interference in invention goes we can not, from our limited remembrance, say.

Arndt & Marcus, Berlin: Conspicuous was a mantel clock, of onyx with gilt ornaments and dial of onyx, about 18 inches high, the front supported by two female terminal statues of gilt bronze and surmounted by an urn of onyx and bronze—an elegant and artistic piece of work. A porcelain clock, about 3 feet high, elaborate in design and painted with great skill, having gilt figures and ornaments, was marked at $250. A clock, about 2 feet high, with red marble base surmounted by two bronze male and female figures, was a beautiful work of art, marked at $350.

W. Dieckman, Celle, Hanover, exhibited an eight-day geographical, astronomical, and chiming clock, with its pedestal about 9 feet high. Besides the main dial the clock had on the left side of the case 8 dials and the same number on the right side, showing the time in 16 of the principal cities of the world. On the side opposite the main dial was a dial with a perpetual calendar which indicated the day of the week, the day of the month, the time difference between mean and solar time, and the phases of the moon. The clock and pedestal were highly ornamented with 54 sculptured representations and decorations.

J. Graschkus, Berlin: A hall clock, with a wide, four-sided base, ornamented with gilding and paintings, dial in arabesque work, body of the clock in graceful and exquisite design, with chain weights, was in all probability the finest exhibit in hall-clock cases in the Exposition.

C. F. Rocklitz, Berlin: In the tower of the German Government building was a turret clock by this maker that had some new principles of construction. The weight of the fourth wheel and pinion gave impulse to the pendulum upon the gravity principle. The system is somewhat complicated and can not be well described without illustrations. The hands moved at each interval of fifteen seconds. The train and weights were heavy enough to control the hands under all ordinary circumstances, but there are doubts in regard to its being any improvement over the ordinary double three-legged gravity escapement, which can only be settled after a long trial of its performance.

Emil Krohne, Berlin: An exquisite boudoir clock in red Nuremburg faience with a white porcelain dial ornamented with gilt bronze figures and surmounted by an urn was a superb piece of workmanship; also a clock in a blue Nuremburg faience vase with a gilt urn on top and supporting figures on each side.

Franz Pecher, Carlsruhe: Three hall clocks with cases elaborately carved and painted and a trumpeter clock designed by Professor Goetz, with very handsome wood carvings, were deserving of much attention.

Otto Schulz: A clock about 2 feet high with a dial on a globe supported by a base and surmounted by a figure of Fame on the wheel of fortune was a highly artistic production.

J. C. Schweitzer, Munich: A silver elephant over 3 feet high with gorgeous trappings, bearing on his back a houdah containing a clock, on two sides of which were dials. In front of the houdah were figures of Venus, preceded by a Cupid on the elephant. On the top corners of the houdah were four griffins, the hands in the form of serpents. It was a very remarkable and impressive production.

J. Jagemann, Munich: A collection of very small gilt clocks containing watch movements was very attractive. A square gilded table clock, with silver dial, bell in cupola, and Venus on a terminal was very beautiful in design. An old-style clock with inscription, "Experience comes in time," was also very pretty.

Jahresuhrenfabrik, Triberg, made a display of well-made clocks with torsion pendulums, in gilt cases and square cases with plate glass sides covered with glass shades. They resembled a high class of French work, and were very attractive in appearance. This system was in considerable use in this country fifty years ago in a cheap form of "year clock" that ran a year with once winding, but they soon ceased to be sold by dealers. The style and finish of the clocks in this exhibit render them an attractive and desirable ornament for a mantelpiece.

Junghaus Bros., Schramberg, made a large display of automaton, alarm, wall clocks and regulators, with wooden cases in great variety.

Fredrich Mauthe, Schwenningen, exhibited 100 designs in alarm clocks, cuckoo and quail clocks, regulators with weights and also with springs, and eight-day hall clocks, 200 patterns; specialty in cuckoo clocks; makes all the requisite carvings on the cases. A magnificent hall clock with chimes and the case elaborately carved, and many bracket clocks with carvings of animals, showed good work and artistic taste. Clocks in cases of English patterns, and alarm clocks on the American system in 100 different styles, altogether made this display one of the largest in foreign clocks.

C. Werner, Villingen, had a large collection of eight-day and striking hall clocks, spring regulators running fourteen days, cuckoo clocks, alarm and wall clocks in English styles of casing, musical clock with trumpeter, sold at $300, and in a case the various kind of movements made after French, English, and German systems. This is one of the largest factories in Germany, and makes all the parts of a clock.

F. X. Wildenauer, Munich: Conspicuous in this display was a Columbus musical hall clock, with elegantly carved figures illustrating the history of his discovery, the pendulum bob a representation of the ship *Santa Maria* from the most authentic source—a very artistic production, and valued at $1,200. There was also a large collection of hall clocks with exposed weights and pendulum, and wall clocks in cases of many different styles, all showing good and very creditable work.

C. W. Schweyer, Munich, exhibited a very large and handsome wall clock in a white and gold case highly ornamented with carvings, and other well-constructed clocks in cases with Bavarian style of carving.

Joh. B. Beha & Son, Eisenbach, made a remarkable exhibit of 8 cuckoo clocks, one with the bird in natural size and natural call, a cuckoo clock with echo, another striking the hour, with cuckoo and quail calls, cases painted to represent the Black Forest costumes; also bracket, wall, and musical clocks—a very interesting display of their mechanical ingenuity in this line.

Winterhalder & Hofmeier, Neustadt, had a display of hall clocks with chimes in elaborately carved cases, bracket and mantel clocks in English and German styles of cases, all exceedingly fine workmanship.

M. Ballin, Munich, exhibited elegant hall clocks with cases artistically designed and executed with great skill, all showing excellent work.

W. Quehl, Berlin: A mantel clock of Algerian bronze, highly ornamented with bronze figures in the style of Louis XVI, and two Louis XV clocks in black cases with gold ornaments, were exquisite in design and truly works of art.

Ette & Mischeke made an exhibition of 7 hall clocks with open and closed cases in different styles and profusely carved in beautiful designs.

Thomas Haller, Schwenningen, exhibited well-made wall and mantel clocks.

Robert Pleissner, Dresden, made a display of wall clocks and table clocks after copyrighted designs; had awards at Munich, 1888, and Dresden, 1891.

Hermann Söfner, Munich, made an exhibit of Rococo and wall clocks.

Wilde Brothers, Villingen, had a collection of wall and table clocks.

L. Furtwangler & Sons exhibited hall clocks, with open and inclosed weights, in very handsome cases.

Jacob Bradl, Munich, displayed elegant Rococo clocks.

C. Leyer exhibited a large clock in the form of a beer keg, surmounted by a figure of Bacchus, the dial being on the head of the keg.

Emilian Wehrle, Furtwangen: Very large bracket clocks in elaborately carved cases, with automaton flute players and trumpeters, and singing birds of various kinds, made a very large and meritorious display.

Maurer & Höffer, Eisenbach, exhibited mantel and bracket clocks in artistically carved cases; also in cases resembling English manufacture; all very creditable work.

R. Schneckenburger, Mühlheim, made a very large display of bracket and mantel clocks in well-made cases resembling English styles, also hall clocks and regulators of good workmanship.

Theod Hahn, Stuttgart, made an exhibit of improved electromagnetic watchmen clocks, all well made.

Alfred Conti, Berlin: Central and signal-service clocks and Urania pillar clocks appeared to be his special manufacture.

Etzold & Poplitz, Leipzig, had principally wall and mantel clocks.

J. N. Eberle & Co., Augsburg: This firm, established in 1836, employs 300 workmen, and probably made the most extensive display of watch and clock mainsprings of all kinds, saw blades, and files of all sizes, and as small as needle files. They had prizes awarded to them at London, 1862, and Paris, 1867.

Herm Wölfe, Kronstanz, makes a specialty of phosphorescent or luminous clock dials of glass and pasteboard for night use, as well as by day.

Charles Schweizer made a display of large and small enameled clock dials of good workmanship.

August Schwer, Triberg, exhibited small clocks, well made, in cases of attractive forms and styles.

Fredr. Pfahrer, Triberg, displayed a large number of exceedingly small wall clocks in fanciful cases.

Lorch, Schmidt & Co., Frankfort, had a large collection of all kinds of tools for watch and clock makers' use, well made and of excellent quality.

AUSTRIA.

This country, so celebrated for clock making, made no special display in this group, but among the various art collections were the exhibits of eight manufacturers, whose elegant productions were chefs d'œuvre in this art.

Victor Stiassny, Vienna: In this collection was a magnificent mantel clock 3 feet high in a black Vienna china case, green enameled dial, and gilt-bronze ornaments—a remarkable production. A grand wall clock in blue Vienna china case with gilt ornaments was a very elaborate and highly deporated design. Small mantel clocks in exquisitely designed cases artistically ornamented were superior productions.

J. Kalmár, Vienna: In this display was a clock in a bronze globe surmounted by a gilt figure of Mercury, a highly artistic piece of work; also magnificent mantel clocks in gilt-bronze cases with figures of a high class in art.

C. Lux, Vienna: In this collection were a number of exquisitely beautiful mantel clocks in gilt-bronze cases ornamented with figures of great merit.

Robert Pilz, Vienna, had in his display clocks in enamel and bronze cases ornamented with beautiful paintings on porcelain.

Dziedzinski & Hanusch, Vienna: This superb collection contained magnificent mantel clocks in cases entirely gilt, with highly artistic figures.

J. Zekert, Meisterdorf: A line of exquisite boudoir clocks and clocks in Bohemian glass and gilt-bronze cases, beautiful in design, made a collection of great merit.

Prof. Schwartz & G. Lind: A large mantel clock in square gilt-bronze case with bas-reliefs and figures was grand and highly artistic in design.

Ed & F. Richter: A magnificent mantel clock 4 feet high, entirely gilded, and supported with superbly executed artistic figures, was sufficient to give this house a world-wide reputation as masters in this art.

DENMARK.

This country has a world-wide reputation for the finest horological work. The Jürgensen family, of Copenhagen, of which Urban Jürgensen and Jules Jürgensen were prominent members, constructed watches that were surpassed by none in their day for elegance of form, construction, finish, and time-keeping qualities, but no exhibit of watches was made showing the state of the art there at the present time.

Bertram Larsen, Copenhagen, exhibited a small turret clock with a Graham escapement, constructed so as to show the time either mechanically or by electricity, or both ways at the same time. Here electricity was used. The two dials of the turrets at the entrance to the Danish section showed Chicago and Copenhagen time, respectively. The commutator was claimed to be an improved construction.

GREAT BRITAIN.

In this section there were but two exhibitors in this group, representing principally the clock-making industry. It is much to be regretted that exhibits of their marine chronometers and watches, made in the renaissance of the art, during the past fifteen years, in England, were not sent here, as they would have been of exceedingly great interest to many people in this country. The introduction of American machine-made watches into Great Britain and her colonies, and their large importation of Swiss watches, have stimulated them to the exertion of their greatest energies to keep them from losing entirely this great industry. We should not undervalue their products, for they have now become immense both in number and quality, and may make a serious impression in the markets of the world. In the Revue Chronometrique for November, 1889, it may be found that Mr. E. Antoine, a juror at Paris in 1889, says, in regard to English watchmaking, "they equal if they do not excel their predecessors in every country, and that is the impression caused abroad." Our makers should seriously consider the situation, and not go "complacently asleep in the conviction that they have set up limits" with machine-made watches, for they may be woefully mistaken.

Goldsmiths and Silversmiths Company, London: Among the many grand productions of this company was an "Exposition clock specially designed and manufactured for the World's Fair in 1893." The case was about 8 feet high and octagonal in form with elegantly chased and richly gilded ornaments, the cotton plant and flower being the principal subjects. The case had eight panels, representing the sports, swimming, running, yachting, cycling, baseball, trotting, and jumping, with a view of Brooklyn Bridge. Each panel was surmounted by a portrait of Washington, Lincoln, Grant, Franklin, Jackson, Harrison, and Cleveland, respectively, and a medallion portrait of Queen Victoria. The clock had four dials, showing English, American, French, and Spanish time. About 4 feet from the floor, on a platform around the clock, were twelve figures, representing players in cricket, rowing, shooting, polo racing, La Crosse, boxing, running, tennis, football, and wrestling, which revolved in procession as the clock striked each quarter hour. Above at the sides of the dials four columns supported brackets with vases, between each of which were figures signifying progress in art, science, industry, and engineering. The American eagle was shown above each dial. At each hour the American and English anthems were played, the time being denoted by a chime of 8 bells, the Westminster chimes on four gongs, and the hour on a gong. All can be repeated at will, imparting to the whole work a realism and effectiveness they claim has never before been attained in any similar production. The clock movement and other mechanism showed the good work characteristic of English manufacture. An eight-day hall clock in solid mahogany case, being a copy of old Chippendale clock with Westminster and cathedral chimes with a gilt silver dial, was a masterpiece in this art. They also exhibited chatelaine watches highly decorated and gentlemen's watches, elegantly cased, inclosing movements of excellent make.

J. Smith & Sons, Clerkenwell: Chiming clocks appeared to be a specialty with this house; hall clocks, with elaborately constructed and ornamented cases, giving Whittington chimes on eight bells, Westminster chimes on four gongs, Cambridge chimes on four bells, and chimes on eight suspended tubes, the hours being struck on a very large tube. Also pedestal and mantel clocks with chimes, in ebony cases, with bronze ornaments, and grandfather clocks, all of that standard construction and excellent manufacture so long known in English workmanship; prices from $150 to $800. In a glass case was a small turret clock with gravity escapement.

Marcus Benjamin, Sydney: In the New South Wales pavilion were two remarkable watches. The inventor and maker, Mr. Benjamin, claims important improvements by which the mechanism of the center seconds movement is reduced 75 per cent. They were independent, dead beat, center seconds stop watches, and surprisingly well made, coming

from that part of the world. As far as could be seen of their construction, without taking them apart, the independent train received its going power from the time train through a small spring, like a balance spring that was coiled around, and its inner end fastened to a pinion's shaft of the time train; around the spring was a very small band with teeth on its periphery, this little spring, like a Patek mainspring, had its outer end loose, so that when the independent train was stopped the little band that gave impulse to it also stopped and the hair spring, in the little band, with its outer end loose, was carried around continuously by the time train until the independent train was started, when the friction of the outer end of the little coiled spring, with the inside of the little band wheel, would carry the band wheel around and move the so-called independent train. In reality the time train is expending continuously, whether the independent train is going or not, some of its power in winding up this additional spiral spring. In an experience of more than fifty years we have seen two other watches constructed on this principle for carrying the second hand, so that probably in this advanced age it will be difficult to introduce this new system into commerce.

FRANCE.

In the manufacture of clocks in the highest class, this country surpasses all other nations in the vast product that is exported to all the civilized portions of the world. A wonderful display was made from the diminutive and beautiful traveling clock to the grand, almost monumental constructions designed by their ablest artists. The immense capital invested in this industry almost surpasses belief, and the number of people engaged in the business is enormous; one firm of clock and watch makers at Beaucourt has a capital of $10,000,000, and the extent of their works is colossal. The good and artistic work produced at Besançon has been widely known and appreciated for many years; in 1883 the number of watches made there was 501,602, valued at about $5,000,000, but owing to the use of automatic machinery in watch making at other localities and the old system of hand work being retained there, the production had fallen off to 366,197 watches in 1888, valued at $3,000,000. They are now more prosperous, and with their great artistic skill will soon rival other great producing localities with their great output in number, quality, and price.

This country has made remarkable progress in watch making, owing in a measure to the great interest taken in fostering horological schools, but from the few exhibits made a proper idea could not be formed of the great extent of their output or the wonderful skill they possess in all branches of this industry. Their talent in decorative work and in forming designs for clocks has here full play, and they

exercise it to a surprising extent, as was shown in the great variety of magnificent examples of their art. In giving a description of many of these masterpieces words will fail to convey to the mind their wonderful beauty, only by giving many days of study to their artistic merits could a proper idea be formed of their surpassing excellence, for they were really combinations of sculpture and painting on metal, porcelain, and marble.

B. Haas, freres, made the largest and most complete display of watches in this section, consisting of minute repeaters with split seconds, perpetual calendar, and moon's phases, a self-winding minute repeater with two dials, a repeater that automatically struck the hours in passing and having split seconds, a minute repeater with two dials and two trains, one-fifth of a second and second hand on same axis, on reverse dial a perpetual calendar, moon's phases, and metallic thermometer; a splendid line of complicated watches of all combinations; chatelaine watches in great variety with highly decorated cases, some in the forms of beetles, butterflies, etc., ornamented with unique designs and incrusted with diamonds, pearls, and exquisite paintings on enamel; a wonderful watch in green enamel case, artistically decorated with diamonds in exquisite designs, the dial green enamel with figures in gold, this side also magnificently decorated with diamonds in artistic designs; the very smallest of watches in a ring, and one in a rosebud which opened by pressure, disclosing the dial; a line of cheap watches, from $1 to $10, filled cases with 18-jeweled movements, nicely finished, costing $6 in France, and full-plate movements in steel cases ornamented with niello work.

Société Anonyme, Besançon, made an elegant display of minute repeaters and chatelaine watches artistically decorated with diamonds, rubies, and enamels, also individual parts of watches and elegantly made traveling clocks.

Louis Ancoc, fils, Paris, exhibited a tiny watch in a ring, surrounded with rubies, and three large diamonds on each side, and two extremely small watches with chatelaines, wonderfully decorated with diamonds and paintings on enamel.

Drocourt, Paris, displayed highly decorated chatelaine watches, a very small minute repeater, and a chronograph. This house is also noted for good quality in traveling clocks partially made at the factory in St. Nicholas d'Alièremont near Dieppe and finished in Paris.

H. Houdebine, père et fils, Paris: The following clocks in this exhibit were remarkable productions. A marble column on a highly ornamented base supported a dial about 7 inches in diameter; on the sides two female figures about 18 inches high holding wreaths of flowers hanging from an urn was exquisite in design. A clock in gilt bronze and lapis lazuli designed after a clock that belonged to Marie Antoinette; a serpent points with its tongue to the hour figures on a

revolving band and the minutes on a narrow band above. A clock in silver case with figures of Cupid and a dragon; a Louis XV pastoral movement in a blue enameled globe with stars surmounted by two doves and supported by three cherubs; a beautiful Louis XVI clock was a column of pink marble supporting a movement surrounded by designs representing the King of the Sun supporting figures of Venus and Cupid in bronze; a large gilt clock in a shell surmounted by a bronze Venus in a car drawn by two Cupids was highly artistic; a clock in a chariot drawn by a dragon and driven by a Cupid was exceedingly beautiful; in marble and bronze Louis XVI style, a movement supported by a bronze eagle.

A. Beurdeley: A reproduction of a clock made for Louis XV, about 7 feet high, had four legs about 3 feet high like a table, very antique in design, had center seconds and hands showing the day of the week, month, moon's phases, and year, case surmounted by celestial globe inclosed in a globular glass casing; a hall clock in ebony highly ornamented with designs in gilt bronze, surmounted by a group of bronze horses driven by Apollo in a chariot; large and splendid mantel clocks in antique and Louis XV styles with cases extremely beautiful in design, and surmounted with exquisite and highly artistic figures.

Fernand Gervais, Paris: A Louis XVI clock 4 feet high, in gilt bronze with red marble base; price, $2,200; for the candelabras, $2,600. Reclining in front of the clock was a female figure, sculptured in Carrara marble by Carrier Belleuse; the marble cherubs also by the same artist. A reproduction of a porcelain clock in the form of a vase, supported by bronze figures, in the Kensington Museum, that belonged to Marie Antoinette, was about 15 inches high, had gilt ornaments, and was exquisitely decorated with paintings; the clock dial was in the body of the vase. A reproduction of a clock in the Trianon that belonged to Marie Antoinette was 3 feet high, a dial in the body of a harp ornamented with gilt bronze designs. A clock in a red marble vase about 3 feet high with bronze ornaments, supported by two beautiful bronze female figures 2 feet high was a very artistic production; price, $1,000. A clock in a gilt bronze column with a bronze cherub as an artist holding an exquisitely painted portrait on enamel, marked $800. A large blue enameled globe contained a clock supported by two gilt bronze female figures. On a pink marble base two bronze figures carried a highly ornamented gilt bronze sedan chair containing a clock.

Emile Colin & Co., Paris: A design by Marioton was a column about 7 feet high supporting a clock in gilt and enamel work after the antique; a life-size figure of Diana, gilt, was attached to the column; on the column about midway of the figure was a gilt Cupid. This was the most artistic and imposing work of art in this line in the

Exposition. Two female figures supporting an urn and clock about 3 feet high was another magnificent and artistic production.

Lamaille & Co.: A splendid hall clock in variegated onyx and red marble, with gilt ornaments, was a gorgeous construction; price, $1,200. A very large collection of mantel clocks, from the smallest to the largest size, in porcelain and gilt cases, and two large wall clocks were also of superior manufacture.

Millet: Two exquisite clocks, reproductions of Louis XVI styles, and one in the form of a blue globe, with Cupids; another like it, but with a gilt bronze figure reclining over the top, were artistic productions, as also were two very high hall clocks with elaborately ornamented cases, after Louis XV and Louis XVI designs.

Desiré Disclyn made a very interesting and unique exhibit of clocks in cases of forged iron, after antique designs, showing the great resources of the artist in art metal work. The impression this exhibit made was very strange, carrying one back centuries, when such work showed the artist and master workman in forged iron.

F. & Ch. Pierre: This house had a large line of mantel clocks in highly ornamented porcelain cases, with lever escapements and balances, black and bronze cases, with pendulums, and a large number with Algerian onyx cases—all elegant in design and finish. Conspicuous was a clock about 4 feet high, in Algerian onyx, with the Marly horse tamers in gilt bronze as supporters; dial rim in onyx; in the center a representation of the landing of Columbus; all surmounted by a gilt bronze statue of Columbus in a sitting position, with a globe in his hand; price, $2,000.

Villon, Paris, exhibited a most exquisite line of traveling clocks, from the smallest to the largest sizes, all in gilt and crystal cases, showing a high class of workmanship in the movements. In his factory at St. Nicholas he claims to make every part of his clocks, from the little ticktacks and alarms to regulators and chiming clocks, and was expert to the jury at Paris, 1889.

Passerat, Paris, made a specialty of reproductions. On a pedestal was a Louis XVI clock, about 4 feet high, designed by the artist Berain, from one in the reception rooms of the Tuilleries; black case, inlaid with metal; glass front and sides, highly ornamented with figures in gilt bronze, surmounted by a figure of Time sitting on a globe; price $835. A square clock on a pedestal, all 8 feet high, in ebony, with gilt ornaments, silver and gilt dial with gilt figures in basrelief, sole reproduction of one presented to the Paris Observatory by Louis XIV, was designed by Coypel and executed by Caffieri; price $1,600. Three mantel clocks in square cases, and a bracket clock, 3 feet high, in red enamel and gilt bronze were artistic productions. A wall clock of the Palais de Justice, design by German Pillou, was one of the finest reproductions of the renaissance period; price $800.

Leblanc-Barbedienne exhibited clocks in beautiful cases of magnificent Persian designs in gilt and enamel.

Louchet frères, Paris, made a display of Louis XVI boudoir clocks in gilt bronze and porcelain; one with two columns of onyx, gilt bronze and enamel, supported and surrounded by birds, was a beautiful design. Clocks in exquisitely painted porcelain vases and lyres, and other designs artistically ornamented with paintings, and supported by finely executed figures, were too numerous to give a detailed description, although deserving of special notice.

Barbedienne, Paris: In this great art collection were 3 clocks that deserve special mention—a beautiful mantel clock in bronze and enamel with Persian decorations; a superb gilt-bronze clock, about 30 inches high, marked $1,200 and a magnifient square-cased Louis XVI mantel clock.

A. Damm & Colin, Paris, exhibited a hall clock in elegant design, entirely gilded and highly ornamented, a remarkable piece of workmanship.

Glazener & Co. made a large exhibit of clocks in porcelain, onyx and gilt cases, traveling clocks of all sizes, some with exquisitely gilt dials, regulators, and a large gilt Louis XIV clock on a socle with candelabras, all choice works of art.

Charlot frères: A magnificent mantel clock, square in design, with four columns in blue enamel and gilt, with blue enamel and gilt dial and gilt figures, the dial sourrounded by four female figures painted in a highly artistic manner, was a remarkably beautiful production.

Peconnet, Paris, exhibited a line of superbly made watch cases, grandly decorated with diamonds and enamels.

A. Moynet & Co., Paris: These extensive dealers in watch and clock material made a large display of tools and watch material of the best manufacture.

Grisot Saillard, Besançon, made a display of superbly made mainsprings of all sizes, having all the good qualities required by the best class of watches.

SPAIN.

This country had only one exhibitor in this group, but the exhibit was a surprise in the wonderful skill and perfect work shown in metal incrustation.

Mrs. Filipa Guisasola, Madrid: In the Spanish section was a remarkable exhibit of gold incrusting on blue black steel. On watch cases made of steel was some of the most beautiful work in this art ever seen; the designs were so beautiful, graceful, and exquisitely delicate that it would seem to be vandalism to even wear these cases; they should be kept as art treasures. The designs are first engraved on the steel in an undercut; the gold is then applied, fills the engraved lines

and raised above the surface of the steel, then finished by hand engraving. As the largest example of this remarkable kind of work, a vase about 3 feet high, with exquisite designs in gold of 8 different colors, was valued at $40,000.

SWEDEN.

In many provinces in this country, especially in Delarme, they display great mechanical skill. Wall clocks, tower clocks, and station clocks are more and more manufactured, and even exported to neighboring countries. In 1890 there were 29 timepiece factories, the largest of which is the Halda Watch Factory, which produces yearly about 6,000 watches in gold and silver cases.

Halda Watch Manufacturing Company exhibited watches of considerable merit in finish and principles of construction; also individual parts of watches in different stages of manufacture, all well made, the jeweling well done, and they make the dials. The cases in gold and silver were also well made, showing the capacity to become prominent in this art. Received awards at Paris in 1885, and Gottenborg in 1891.

G. W. Linderoth: A hall clock, elegant in design and finish, was a very creditable piece of work; also small wall clocks in gilt cases, resembling those in French clocks, strong and well made. The display of wall clocks in gilt cases and in porcelain cases beautifully designed, was particularly remarkable. An eight-day clock in the dome of the Swedish Government building was also of good construction and finish.

RUSSIA.

N. N. Makarovsky exhibited a clock for keeping the time of workmen; also a dining-room clock, both very creditably made.

HYGIENE AND SANITATION.

BY

Miss ANNESLEY KENEALY, Judge.

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HYGIENE AND SANITATION.

By Miss ANNESLEY KENEALY,

Judge of Awards in the Hygienic Department; Lecturer to the National Health Society; Lecturer on Technical Education to the British County Councils, etc.

'Tis life, not death for which we pant;
'Tis life whereof our news are scant,
More life and fuller that we want.

It will readily be conceded that of all the exhibits set forth in the World's Fair at Chicago, there is no department which bears so directly upon human good and human happiness as its great and important department of hygiene and sanitation. Vast business interests are involved in many of the exhibits, and wonderful developments of steam and electricity are shown; and as the sociology of to-day demands that commercial enterprise shall go hand in hand with human need we see much ingenuity displayed in inventions and machines of a practical and labor-saving type, whereby the burdens of the world may be lightened and its yokes made easy. Such assist and further man's progress, but it is hygiene which, by pointing the way, has shown the lines along which these should travel.

The prosperity of a nation consists not so much in its wealth as in the health, happiness, and efficiency of its workers. So that any improvement and development of life conditions may well be regarded as the storing of a national reserve fund which is incomparably more valuable, far and wide reaching in its results than a mere surplus of revenue. And it has been found that sanitation and wholesome surroundings by their effect upon the physique and productive capacity of the individuals affected add substantially to the working value of a population. The relation between health and wealth is absolute and infallible.

Let me now consider briefly such exhibits in the Chicago World's Fair as have seemed to me to place themselves in a superexcellent class. The Pennsylvania State board of health in its plans of improved tenement houses shows that the artisan need no longer struggle for the birthright of every human being—the opportunity of a decent habitation; some degree of privacy, fresh air, light, and sunshine—for such are here proved to be within his reach. In the models shown he has all these advantages combined with a degree of sightliness and orna-

mentation that will help to build up some beauty of mind at the same time that the hygienic conditions of his dwelling will raise his health standard and add to his happiness as a man and his efficiency as a worker. A great advance is shown in the construction of these artisan dwellings, which are excellent examples of modern sanitation. With plans such as these to hand, it will soon be counted a national disgrace that any country should permit its toilers—its "hewers of wood and drawers of water"—to crowd together in dark, unwholesome "rabbit hutches" instead of advancing into the light of day and taking their just share of the benefits of nineteenth century science.

A moderate rental provides not only the proper number of rooms whereby the laws of human decency may be observed, but also affords the luxury of "a flower bed and a playground for the children." A higher, healthier, and more vitalized life of its future generations will reward that legislature which enforces the adoption of these or similar plans on intending landlords.

To supply the needs of a more prosperous class, we have a model workingman's house built on behalf of the Philadelphia County Women's Committee, and almost side by side with the cliff dwellers exhibit we find a workingman's cottage erected by the Improved Dwelling Company, of New York. What a contrast the two present! What an evolution in thought and human need is shown.

From far off Japan is sounded a keynote of health's spreading gospel in the form of an excellent model of marine disinfection and quarantine. Owing to the frequent importation of cholera from neighboring countries through its seaports, the Japanese Government has established, since 1879, six quarantine stations for the inspection of vessels and the disinfection of passengers and cargo from infected ports. By earlier regulations the inspection rules came into force only upon receiving information that cholera had broken out in foreign countries; but, as the report quaintly puts it, "There have been instances when the germ of the epidemic found its way into our harbors before the rumor that it had broken out reached us." Hence the surveillance of vessels from "suspected localities" has been made compulsory. Japan also contributes the rules and history of its Red Cross Society. This society originated from the necessities of the position during the Kajeshina insurrection of 1877, at which time some excellent work was done by its agents in aid of the sick and wounded. The nature of the work is shown by a comprehensive chart, and likewise by a report dealing with the action of the society in times of peace. Valuable assistance is shown to have been given to sufferers from shipwreck, earthquakes, and in national disasters accompanied by suffering or loss of life.

The system of maritime sanitation inaugurated by the Louisiana State board of health is shown by a very complete model demonstrating

the methods by which disease is excluded from the State by disinfection and fumigation at the river quarantine station below New Orleans. By the excellent methods adopted the complete purification of the vessels, passengers, and cargo is insured without unnecessary detention or inconvenience. The report states that the board has thus succeeded "in keeping out foreign pestilence and at the same time has fostered the commerce of its State and section to a gratifying extent."

In the department of public health there is an excellent showing of the work carried on by the various State health boards in the solution of vexed problems relating to sanitation and hygiene.

The State board of health of Massachusetts exhibits charts illustrative of valuable and extensive research work relating to diseases and epidemics, comparative mortality, and the influence of population upon public health. An act of the legislature passed in 1886 authorized this board to examine the domestic water supplies of the State, to take over complete control of these and the inland water supplies of Massachusetts, and to conduct experiments for determining the best methods of purifying sewage. With this object the Lawrence experiment station was established—being the first of its kind in the United States—and this station has made important contributions to the science of pure water supply and the prevention of water contamination by sewage. An interesting model of the station is shown, with photographs, charts, sand beds sewages, sections of filter beds, and other apparatus illustrating its various departments of work.

In the food and dry adulteration department this board makes a very interesting subsection showing the means whereby the public is protected against the sale of harmful and adulterated food products. The board has also done progressive work in connection with the regulation of offensive trades, and has carried on investigations bearing on the sale and uses of opium; the control of infectious diseases and malarial fever; the dealing with intemperance, and many other kindred branches of hygiene affecting the moral and physical welfare of peoples.

The Michigan State board of health exhibits some suggestive vital statistics in the form of charts and pamphlets illustrating the prevalence of diseases in Michigan during different years, the fluctuations in mortality, and general statistics with regard to the health conditions of the State. Some very interesting diagrams are shown exhibiting the influence of meteorological conditions on various forms of disease and the effect of the velocity of wind on diphtheria epidemics. Very significant and satisfactory results of the work of the board appear in the tables of comparison of death rates in Michigan from infectious and preventible diseases before and since the establishment of the State board of health.

The Illinois State board of health exhibits tables and diagrams illus-

trative of the zymotic diseases prevalent in Chicago during the years 1891, 1892, and 1893; it points to the causes and suggests the remedies. The investigation was begun in the winter of 1891–92 during an epidemic of enteric fever in the city of Chicago—an epidemic which caused considerable anxiety and was productive of much ominous prophecy regarding the amount of disease likely to be experienced during the World's Fair of 1893. There is no doubt but that the public attention then called to the health conditions of the city has prevented many foreigners from visiting the Exhibition. Fortunately the loudly predicted outbreaks of typhoid and cholera consequent on the ingress of so many strangers and their inevitable overcrowding have proved themselves to have been baseless. Contrary to all expectation the health of the city has been exceptionally good, and the sanitary arrangements and general hygienic standard have been in marked contrast to the condition of affairs which obtained in Philadelphia during the Centennial.

The sanitation of the "White City" itself was an important subject, and has been most satisfactorily dealt with. In the artistic setting of the grounds, in the lagoons with their picturesque gondolas and gondoliers, we have more than the beauties of old Venice—and we find them combined with health. In most of the old towns of Europe the picturesque and the unhealthy are indissolubly combined. Chicago has shown that art and hygiene may go hand in hand.

The sanitation of the Fair and the provisions made for public health and comfort are beyond all praise. A pure-water supply was insured by the establishment all over the grounds of sterilized water tanks, from which the public might drink without suspicion and without harm. The system of purification by chemical precipitation has been applied to the sewage of Jackson Park with very encouraging results. At the same time a series of experiments has been carried out under the direction of Mr. Allen Hazen, of the Lawrence experiment station, as to the best chemicals which may be employed as precipitating agents. The conclusion of these experiments is looked forward to with great interest, and will, it is thought, be of much value in determining many important points with regard to the most efficient and economical method of sewage treatment.

In the department of agriculture the results of protective supervision with regard to the diseases of cattle and the prevention of animal epidemics are shown by charts and statistics. These give the dates of entry of pleuro-pneumonia into the various counties and the means taken to establish quarantine lines, and so to prevent this and the disease known as "Southern" or "Texas" cattle fever.

In class 829 of group 147 the commissioners of sewers of the city of London exhibit a model demonstrating an efficient system of street cleaning and the treatment and disposal of sewage. With this may

be mentioned a model of the admirable crematorium at Woking, England, for the hygienic disposal of the dead. And notice is deservedly made of the Engle Sanitary Cremation Company, of Des Moines, Iowa, for their excellent scheme of garbage cremation as applied to the destruction of household waste and their method of dealing "with the excreta, waste, and infected material at medical schools and hospitals in an entirely sanitary manner, with no escape of disease germs," disposing of the total production of garbage, refuse, dead animals, and miscellaneous waste of cities and towns without nuisance, with no escape of fumes and in a speedy, economical, and satisfactory way."

The models and photographs of abattoirs and dust cart from the New York Ladies' Health Protective Association are worthy of attention, showing, as they do, improvement where improvement was sorely needed.

The exhibit of the Battle Creek Sanitarium is a very important contribution to sanitary science. It is an almost perfect exhibition of what a modern sanitarium should be. The models of the buildings are evidences of the skill that has been bestowed upon the construction, the heating, and the manifold hygienic needs of such an institution; while the mode of treatment, the system of exercises, and methods of physical development show a material advance in the right direction. A series of popular charts illustrate with a simple but vigorous eloquence the dangers and results of improper living, unsuitable clothing, intemperance, and the many vices of "civilized" conditions. Hygienic clothing, health foods, and many allied exhibits go to make up a most creditable display, and one which is calculated from the amount of attention it has attracted to develop a strong public interest in the vital question of health.

In class 829, group 147, Germany is much to be commended for her excellent plans of public buildings constructed on lines essentially adapted to health and comfort. In her models of sanitaries for children, drawings of hospitals and insane asylums, construction, lighting, heating, and ventilating of the German parliaments, schools, town hall etc., she reaches the highest standard of hygienic architecture. These designs for hospitals and asylums are models for the world.

It is much to be regretted that but little has been shown in connection with class 830 of group 147. This section embraces the hygiene of the workshop and factory, illustrations of diseases and deformities caused by unwholesome trades and occupations, and methods for obviating such distresses. More important fields of knowledge and research can scarcely exist, yet they show here as having been practically passed over, as indeed have many other valuable departments of hygiene and sanitation. The absence of the element of commercial stimulus must necessarily limit the exhibits in a department largely representative of philanthropic operations.

The necessary expenditure involved in such displays can not easily be spared by those on whom charity is making exhaustive demands. For this reason the hospital world is by no means exhaustively represented.

Notable among the hospital exhibits is that of the Johns Hopkins Hospital at Baltimore, an institution which contributes in a most progressive spirit to the interest of this section. In the models and photographs shown it is evident that the construction and methods of this hospital approach perfection as nearly as is possible, according to our present light.

The McLean Hospital for the treatment of the insane is also an excellent type of such an asylum. This was one of the first institutions which established a school for training nurses in work among the insane—a valuable step in the right direction. The scheme of treatment laid down is admirable; gymnastics, billiards, and various recreations, indoor and out, are established with good results, every effort being made to bring the patients under a refined and homelike influence, such as must lighten the miseries, if not materially bettering the mental condition.

The British nursing section includes a very complete collection of sick-room furniture, hospital uniforms, invalid appliances, and comforts for institution, district, and home use, and is an admirable type of what such an exhibit should be. The growth and development of nursing from a crude art into a completed science is very strikingly shown, while many interesting relics and mementoes of Florence Nightingale, Sister Dora, and other pioneers of skilled nursing lend a personal interest to the display, which is one of its most attractive features. The president of this department, Mrs. Bedford Fenwick, is much to be congratulated on having contributed to the Fair so scientific and advanced a presentment of the modern art of nursing.

Note must also be made of Miss Kate Marsden's beneficent scheme for the establishment of leper colonies in Liberia for the reception and care of sufferers who at present are practically houseless and homeless. The models of the proposed buildings aroused much popular attention. The ambulance system as applied to the Fair grounds, whereby sufferers from accident, prostration, and faintness, might be immediately removed and cared for is worthy of the highest praise. The scheme was admirable in conception and was carried out with perfection of detail and enthusiasm of spirit on the part of the workers.

The establishment of hospital substations in convenient parts of the grounds for the reception and treatment of patients was shown from the number of cases dealt with to be a necessary, wise, and humane provision on the part of the authorities. Some thousands of patients were admitted and treated in the emergency hospital during the six months of the Fair. At the homeopathic headquarters, the Illinois Training School, and the office of the St. John's Ambulance Society of

England excellent assistance was daily rendered to large numbers of persons overcome by heat and suffering from the accidents and ailments incidental to overcrowding and fatigue.

In conclusion I would add that I regard it as a high privilege to have been officially associated with the World's Fair, and as a great addition to that privilege to have been invited to contribute this history of the section to which I was attached. My only regret is that the pleasant office was not intrusted to one who might have done greater justice to the merits of this department of the greatest Exposition the world can ever hope to see.

INSTRUMENTS OF PRECISION OTHER THAN ELECTRICAL AND MAGNETIC.

BY

J. H. GORE, Judge.

INSTRUMENTS OF PRECISION OTHER THAN ELECTRICAL AND MAGNETIC.

By J. H. Gore, *Judge.*

Instruments for scientific measurement may be classified as follows: Instruments for facilitating arithmetical and geometrical calculations, mechanical measuring appliances, surveying and engineering instruments, meteorological instruments, horological devices, instruments for measurements of heat, and optical instruments.

INSTRUMENTS FOR CALCULATION.

The past decade has witnessed nothing more than unimportant changes in the instruments of this class, none of which can be regarded as offering improvements upon the efficient arithmometers of Thomas and of Colmar. Grimme, of Braunschweig, exhibited a compact machine for simple computations, while Blanc showed an apparatus for logarithmic computations, and Kloth, of Osnabruck, had an ingenious device for the determination of the area of a triangle. It consisted of a plate of transparent celluloid, upon which was drawn a hyperbolic curve whose equation was $\frac{xy}{2}$=a constant. By placing this plate over the triangle so that the origin coincided with one vertex and the axis of x with the base, the reading on the curve corresponding to the altitude gave the area, approximately.

Several planimeters were shown, none presenting marked novelties, except a cartometer made by Tesdorpf, of Stuttgart, which appears to combine simplicity and accuracy. With it lines can be traced backward and forward without interruption, the wheels being thrown in or out of gear according to the direction in which the apparatus is made to follow the lines. The absolute length results immediately from the arithmetic mean multiplied by a factor which is constant for each instrument.

MECHANICAL MEASURING INSTRUMENTS.

Included in this class are a series of instruments of recent origin known as seismometers, for measuring the direction and amount of earthquake disturbances. The newest type of seismometers, especially the perfected form of Professor Milne, not only measures but records

its measurements. Especial attention is paid to seismological investigations in Japan, and, as might be expected, the exhibit of instruments of this class from Japan was extensive and important. Chronographs for recording minute intervals of time were exhibited by several makers. The only feature noticeably new is the introduction of rapidly acting electro-magnetic tracers with a view to reduce the errors of observation.

Saegmuller, of Washington, showed a compact chronograph which possessed the ability to change its stroke from seconds to double seconds at the will of the observer. It was also provided with a gravity governor, which insured the desired uniformity of rate.

Professor Hough exhibited a printing chronograph of a form previously described.

Balances in great variety were shown, each striving to embody the advantages of precision, stability, and economy of time. Short beams were quite the rule, and various damping devices employed to bring about a dead-beat motion, thereby reducing the reading time to the minimum.

Bunge, of Hamburg, exhibited a form of balance for heavy loads, in which the pans are skeletons in order to reduce the effects of the currents of air. He also had a smaller analytical balance, with reading telescope, with arrangement for mechanically charging or discharging the weight pan, without opening the casing. By means of sliding carriers having the values of the respective weights marked on them, each weight may be placed exactly in the center of the pan, which consists of 17 concentric brackets arranged one above the other; the mechanism is such that no vibration, friction, or accidental dropping of weights can take take place. By turning a crank forward the frame supporting the carriers descends, the carrier is liberated and may be withdrawn from under the weight. The balance is thrown into action by turning the crank in the opposite direction. As in this case the pointer swings out only 1 degree per milligram, the tenths of a milligram may be read off in the telescope directly and the hundredths may be estimated. The rapidity of the oscillations has, therefore, in this balance been reduced in such a way that it is to that of an equally sensible short-beam balance in the ratio of $1 : \sqrt{10}$. The pan for the weighing charge is made of rock crystal. The rider slide is accurately notched on the dividing engine. The pointer is of a triangular form, to obviate vibration. Length of beam, 13 centimeters; sensibility, 0.05 milligram.

The United States Coast Survey also showed some balances, which will be referred to later on.

Cathetometers, or instruments for measuring heights of points above a fixed plane, were represented by two specimens, one from the Geneva Company and the other from G. Standinger & Co., of Giessen. The latter was provided with bronze prism, solid silver

divided scale 1 meter in length, and an inclinable telescope and level. The correction of the telescope, due to errors in the prism, is made on the sliding piece above the focusing point, in this way compensating the errors of the prism. The prism and eccentric parts are counterpoised and the whole revolves on a vertical axle.

Hydrostatic instruments were exhibited by the German bureau of standards, though nothing especially novel was shown, except Siemen's alcoholometer, which measured and registered the strength of spirits passing through and at the same time measured and recorded the amount of the same. The connections of this apparatus with the still and the dials being under the absolute control of the revenue officers, it makes false returns and spurious distillations impossible. In this connection reference must be made to the extensive and important publications of this institution.

SURVEYING INSTRUMENTS.

All instruments of this class on exhibition gave evidence of the same tendency. Lightness and stability of parts, a reduction in the size of circles made possible by improvements in graduating and reading circles, and an increase in the light-gathering power of the telescopes are some of the directions along which the improvements are made. For a time it was hoped that aluminum would be just the metal to furnish the dual qualities of lightness and rigidity, but a very little experience sufficed to show that the hope would not be realized. However, it is playing a somewhat important part in some of its alloys. Phosphor-bronze was used in many instruments for wearing surfaces.

The most conspicuous contrast shown was along the line of theodolites, transits, etc., when comparing the general American model with the German model. The former is more compact, the circle is nearer the tripod head, and the vertical axis, even when long, extends downward sometimes below the top of the head.

The most marked improvements shown were: A "Cleps," by Salmoiraghi, of Milan, which was a transit with the horizontal and vertical circles inclosed within a box, and readings made by means of microscopes; rapid-leveling tripod heads, by Buff & Berger, of Boston, and Saegmuller, of Washington; superior drawing instruments of Alteneder, of Philadelphia; and the cylindrical and cone-shaped drawing instruments of Riefler, of Munich. The variety and general excellence of the large displays of Queen & Co., of Philadelphia; W. & L. E. Gurley, of Troy; Manasse, of Chicago; Keuffel & Esser, of New York; and especially the large, well-arranged, and carefully catalogued collection of instruments brought together and installed by the German Society of Optics and Mechanics; and a tachygrapho meter, by Tesdorpf, of Stuttgart. This instrument, intended for

speedily working out general and detailed plans, solves automatically, by purely graphical means, those problems which ordinarily have to be worked out by calculation. It dispenses with the calculation of the coordinates of the position of the rods and the horizontal distances from the center of the instrument to the rod, and also the absolute elevations above sea level are directly projected without the assistance of tables or slide rules. Then, by slightly pressing upon the needle apparatus, the readings are transferred to the paper to any desired scale.

METEOROLOGICAL INSTRUMENTS.

The only marked advance shown by exhibits in this class was in the direction of improved self-recording devices. This was especially noticeable in the barometers, thermometers, and barographs of Darton, of London; Watson, of London; and Fuess, of Steglitz. However, it must be said that the aspirationspsychrometer of Assmann is not only new but valuable, in that it enables one to determine at once, without computation, both the temperature and the moisture of the air.

The Weather Bureau of the United States exhibited at work all of the instruments used in meteorological investigations and observation. It also made regular predictions of weather and printed in its own building the daily weather chart.

The German Meteorological Institute showed a complete set of its publications and a set of its routine instruments.

HOROLOGICAL DEVICES.

Although horology does not fall strictly within the classes here discussed, still three exhibits were assigned to us. The first was an interesting series of historical ship chronometers, including one that was wrecked at Samoa, one used on the Hall expedition, and one that Greely carried to the fartherest north. In addition to these were sets of the parts of chronometers and also a Seth Thomas astronomical clock. The next was an extensive exhibit of the Self-Winding Clock Company of New York, showing clocks in which at regular intervals the clock itself turned an electric current into a motor. This motor running rapidly for a short period wound up a spring of sufficient tension to run the clock for another period. They also exhibited programme clocks so devised that bells would be rung according to any prearranged schedule, and clocks which rang chimes by being provided with a cylinder put in motion at the hour and half-hour. Each cylinder was fitted with brushes disposed in such a way that each brush, in passing a fixed point, turned on the circuit, causing its own electromagnet to strike a hammer against a sonorous tube or bell. The other exhibit of this class was the Riefler mercurial compensating pendulum and an escapement by the same maker and inventor. The former consists of a steel tube, 16 mm. bore and 1 mm. thickness, filled with

mercury to about two-thirds its length. It has further a metal bob weighing several kilograms and shaped to cut the air. Below the bob are disc-shaped weights, attached by screws, for correcting the compensation. By elaborate calculations involving the coefficients of expansion for steel and mercury and the moments of inertia of the various parts, the weight of the bulb has been determined with such accuracy that Director Seeliger felt impelled to conclude his report on the performance of one of these pendulums with the following words:

> From the table of rates extracted from the records of this observatory it appears that with a variation of temperature up to 30° C., no influence worth mentioning on the rate of the clock can be perceived. It is therefore probable that the new pendulum answers all requirements in as high a degree as is ever likely to be attained. A similar perfection has only exceptionally been attained by the ordinary compensations, and even then only after long series of experiments, and, strictly speaking, only by accident, while the distinguished success of this pendulum is based on calculations which may be made in advance with almost absolute accuracy. I therefore feel convinced that this new pendulum of Mr. Riefler's is a most important and welcome progress.

With reference to the escapement, it may be said that it is adapted to all kinds of clocks of precision, and from experiment it appears to secure the greatest possible accuracy. In this escapement the pendulum swings with perfect freedom, being connected with the clockwork solely through the pendulum spring from which it receives the impulse. The impulse is communicated by the wheel work bending the pendulum spring a little at each oscillation of the pendulum, which produces a slight tension in the spring. This tension force of the pendulum spring gives the pendulum the impulse. As this bending takes place round an axis which is identical with the axis of oscillation of the pendulum, and further occurs every time almost at the moment in which the pendulum is swinging through the dead point, we gain not only the perfect freedom of the pendulum, but also the great advantage that irregularities in the communication of force from the wheel work and in the resistances to escape can exert no detrimental influence on the uniformity of the motion of the clock, which is not only in accordance with scientific theory, but has been practically proved by the excellent motion of numerous astronomical, turret, and other clocks provided with this escapement.

INSTRUMENTS FOR THE MEASUREMENT OF HEAT.

Evidence was everywhere apparent of improvements in thermometers, especially in the selection of a kind of glass which after heating shows no residual expansion. The establishing of bureaus for testing thermometers at Kew, Paris, Berlin, and Ilmenan has given an impulse to thermometry which manufacturers have not been slow to take advantage of. Here again we find exhibits of Darton, of London, the Grand Ducal Standardizing Institute at Ilmenan, Ube, of Zerbst-Anhalt, and Schultze, of Berlin. The substitution of the liquid alloy

of potassium and sodium in place of mercury has enabled makers to construct thermometers reading up to 500° C. No attempt was made to exhibit metallic thermometers nor thermo-electric pyrometer. In this connection mention should be made of the standards of length and graduating engine of Prof. W. A. Rogers, of Colby University. The latter makes it possible to graduate a circle and to investigate the errors of graduation, while the comparator gives promise of determining one length in terms of another to any degree of exactness.

OPTICAL INSTRUMENTS.

The wealth of exhibits along this line was very marked, and the general excellence was of a high grade. American makers showed lenses of their own casting and grinding, microscopes and telescopes with novel and original mountings, and opthalmic instruments with many improvements. European manufacturers have continued in their general advance, and now progress has ceased to be marked by geographic boundaries. However, it must be said that a great stimulus has been furnished by Messrs. Zeiss, of Jena, in the introduction of their "apoechromatic" lenses, and the use of a new glass made by Schott, of Jena. This glass is the outcome of scientific investigations on the correlation of the optical properties of glass and its chemical constitution, which formed the starting point of the smelting of glass in Jena, have at the same time resulted in a considerable extension of the number of glasses which may be applied for purposes of practical optics, and opticians have now a series of new types at their command which vary considerably from the older crowns and flints with respect to refractive and dispersive power. This extension of the range of available material led in several provinces of practical optics to valuable improvements, which naturally originated in Germany. Telescopical optics is that department which hitherto has derived the least benefit from the new glasses. Partly on account of the difficulties attending, with some of the new glasses, the production of large disks sufficiently free from defects, and partly because of the aptitude of these fusions to yield to atmospheric influences, it has been deemed wiser to continue to employ the older types of crown and flint glass for the manufacture of telescopic objectives. In the construction of photographic lenses, and of the microscope, the greatly extended range in the refractive and dispersive powers of the glasses has in the meantime given rise to many practical successes in valuable combinations, which with the older material could not possibly be produced. In the case of photographic lenses, this success is mainly due to the fact that with the new glasses achromatic doublets may be constructed in which at will the positive or the negative member may be made to have the higher refractive index, whilst with the older material achromatization of a collective lens always assigned the higher refractive

index to the negative, in the case of a dispersive lens to the positive member. The removal of this limitation, which was mainly effected by the introduction of the Jena baryta glasses, has resulted in a series of new photographic combinations. In the case of the microscope the conditions for the utilization of the progress made in glass smelting were much more favorable; for in this case also such fusions could be employed which are obtainable only in relatively small quantities, and furthermore the material is in a much less degree required to resist external influences. Consequently, even such glasses as the phosphate and baryta glasses have been largely employed in microscopic lenses, though, for those two considerations, entirely out of place in other combinations. These new glass types have furnished the means for vast improvements in the chromatic and spherical correction of microscope lenses and in the increase of the magnifying power of the ocular. The same general improvements were noticeable in the opthalmic exhibits of Jung, of Heidelberg, Lydow, of Berlin, the Augenklink of the German Universities, Baush & Lomb, of Rochester, The Geneva Company, of Chicago, and the Grundlach Company, of Rochester. In several instances these makers showed microscopes, as did Ross, of London. The improvements may be summarized under more accurate focusing devices by using oblique rachet screws, improved objectives, and devices for illumination and polarization.

The projection apparatus has now become a valuable adjunct to all forms of instruction, and here again the makers have kept pace with the wants of the users, as can be seen in the exhibits of Queen & Co., of Philadelphia, the McIntosh Company, of Chicago, and McAllister, of New York.

Because of the great importance of spectrum analysis a large variety of spectroscopes were exhibited, equipped for a great variety of work, and in some cases provided with multiple prisms. In this line Schmidt and Haensch, of Berlin, were large exhibitors.

On account of the great progress made by J. A. Brashear, of Allegheny, Pa., in the manufacture of accurate optical instruments, it may be well to give a somewhat detailed account of his exhibit and his methods of manufacture.

Critically accurate prisms were made from the glass which was furnished him by Mantois, of Paris. The constants of the various wave lengths entering into the problem were determined with very great accuracy, and the curves were computed from these constants so as to eliminate spherical aberration and give the very best possible color correction to the objective. Fortunately, the density of the glass was very nearly equal throughout, so that a spherical figure to each surface was produced by his methods of polishing and "figuring," and, as a consequence, the objective came out exactly as it was computed; and, from the tests made by Professors Keeler, director of the Allegheny

Observatory, and Leuschner, of Berkley Observatory, the glass was pronounced as perfect as could be made from the material at the command of the optician. It has a clear aperture of 18 inches and a focal length of 26 feet 4 inches. He also exhibited a 9½-inch objective, an 8¼-inch objective, and a 6-inch objective, with a number of smaller objectives, which have the same general characteristics as the 18-inch, having all been worked from mathematical computations, and each glass having been critically tested before being sent to the World's Fair. In fact, none of these objectives were made to exhibit except the 18-inch. They have all been purchased, and some were sold before being sent to the World's Fair. One of the objectives that he exhibited is perhaps worthy of special description, although it has been described in the American Journal of Science and Art. This objective was made by Dr. Charles Hastings, and is perhaps the most perfect specimen of an achromatic objective with two lenses that has ever been constructed. When Dr. Hastings made a critical study of the various new forms of glass made at the Jena optical glass factory he discovered a crown and flint, which, when combined properly, gave a perfect color correction. The crown glass was a "potassium silicate crown," and the flint a "boro-silicate flint." Both the objectives made from that glass, according to the critical study and curves given by Dr. Hastings, gave results superior to anything that was ever before attained in the use of two lenses; but it was found that the crown lens would not hold its surface permanently, its deliquescent qualities forbidding its use, and hence he had reluctantly to give up the making of these objectives. It was also found very difficult to secure large disks of "boro-silicate flint," otherwise an absolutely perfect objective of large size might be made by combining two such flints with the crown lens in the center, and, by cementing with castor oil, protect the surfaces from contact with the moist atmosphere. He also exhibited a number of plane and parallel surfaces made for the Michelson and Jamin refractometers. The limiting error in these surfaces is less than one-twentieth of a wave length of sodium light, or, say, one-millionth of an inch. Then come the grating plates, which are corrected either to an optical plane or a true spherical surface within one-tenth of a wave length of light. It would not, of course, be just to claim anything in regard to the ruling, as this is Professor Rowland's part of the work. Brashear polishes and corrects the surfaces. They are then sent to Professor Rowland, who does the ruling, and then they are returned to and by Brashear distributed to scientific men all over the world. The ruling is, of course, the most perfect that has ever been attempted. Wanschaff, of Berlin, and Sir Archibald Campbell, of Glasgow, have of late years made very serious attempts to make these gratings, but there are none in use for high-class work.

Prisms form another part of his exhibit.—The great difficulty that has been met with in producing fine prisms is that so many of them are overcorrected at the edges. His prisms are made perfectly flat up to the extreme edges, and he leaves no error greater than one-fifth of a wave length in the prisms. The prisms of the great Lick spectroscope, and the great Princeton spectroscope, of the Government spectroscope, and the Yerkes star spectroscope, and most all the telespectroscopes of this country and a large number in Europe have been made by him. He also exhibited a number of silvered glass specula which are worked to a true parabolic figure.

In the instrument department he exhibited the large Star spectroscope for the 40-inch Yerkes equatorial telescope. The spectroscope is designed and constructed for the purpose of a spectroscopic study of the stars. It is not designed for a universal instrument, although it can be utilized for other purposes than stellar spectroscopy. It is fitted with a system of prisms and objectives that make it available for either visual or spectroscopic work. The construction is such as to give it great rigidity, and one of the classes of work that it is particularly designed for is for the measurement of the motion of stars in the line of sight. It is also fitted with a diffraction grating for visual observations, and it has every appliance in the way of attachments and accessories for the highest class of modern spectroscopic work. Every morning part of the instrument is graduated so that when the constants for temperature are once determined, the settings for various temperatures can be done with great facility. An independent telescope is provided for both the grating spectra and the prism spectra, which is used to place any star centrally upon the slit.

He also exhibited a "standard" spectroscope, adapted for all classes of work; in these instruments we have embodied a great many features to facilitate spectroscopic work in astronomical research. This spectroscope is adapted to be used with telescopes from 10 inches to 20 inches aperture.

He exhibited a smaller telespectroscope of the same general form, for use with telescopes from 6 inches to 10 inches aperture. A large number of the universal spectroscopes are now in use and give general satisfaction. All the optical parts are made with the greatest precision.

The prisms and objectives of the smallest spectroscope are made with the same care that is expended upon the larger and more costly instruments.

Telescopes were represented by a small equatorial by Saegmuller of Washington, which might be regarded as an evidence of his abilities in this class of work and on a smaller scale showing the improvements which he introduced into his Denver telescope.

Warner & Swasey, of Cleveland, showed their best work in the mounting of the Yerkes telescope built for the University of Chicago.

In designing a large telescope, the first element to which the engineer naturally gives his attention is the tube; for, while its office is a very simple one, being merely to hold the objective and the eyepiece in their proper relation to each other and to enable the astronomer to direct the optical axis to the star, it is an extremely important factor. The two most essential points in the tube are lightness and rigidity, the former for ease of motion and the latter to reduce flexure to a minimum. The material best calculated to give these two qualities seems at the present time to be sheet steel. Some material having aluminum as a base has been sought for, but thus far none has been found giving the requisite rigidity. The form of the tube has much to do with its rigidity, a slight increase in diameter at the center serving to stiffen it to a great degree, and causing thinner material to suffice. No form of internal bracing seems so effective as the same amount of material used in the shell itself. In the tubes of the three large telescopes named there is, therefore, no bracing whatever, all the strains, both in tension and compression, being taken by the sheet steel forming the tube.

The tube for the 40-inch Yerkes telescope is 42 inches in diameter at the objective end, 52 inches at the center, and 38 inches at the eye end. The sheet steel forming the tube varies from 7.32 inches in thickness at the center to 1.8 inches at the ends. The total weight of the tube is 6 tons. The declination axis carrying the tube is of forged steel, 12 inches in diameter and 12 feet long, its weight being 1½ tons This runs in segmental babbitt bearings in the declination sleeve, which weighs 4 tons. The polar axis carrying the whole system is of hard forged steel, 15 inches in diameter at the upper bearing and 12 inches at the lower bearing, and weighs 3½ tons. Just above its upper bearing it carries the main driving gear, weighing 1 ton and having 330 teeth, by which the movement of the driving clock is communicated to to the polar axis. The great weight of the bearings of these axes is almost wholly relieved, and the resistance changed from sliding to rolling friction by means of three bracelets or live rings of steel rolls. One of these encircles the declination axis near the tube and one is placed above each bearing on the polar axis. These antifriction live rings run in steel yokes, and are pressed against the axes by means of adjustable spring levers.

The live ring of rolls which is on the declination axis near the tube is the center of gravity of the system comprising the tube and the declination axis with their attachments, this one series of rolls serving to take the weight off both bearings of the declination axis, and so nearly eliminating friction that less than 1 pound of direct pressure on the tube is required for each ton of weight moved. This live ring is composed of 16-inch rolls, 5 inches long and 3 inches in diameter, and carries a total weight of 8 tons. The live ring at the upper end

of the polar axis is composed of 16 rolls, 6 inches long and 4 inches in diameter. This sustains a weight of nearly 20 tons. The endthrust of all this great weight, due to the angle at which the axis is placed, is taken on a double series of forty 1-inch hardened steel balls.

The methods of balancing the movable parts of the Yerkes telescope have been a special study, with results which seem all that can be desired.

The heaviest accessory to be used with the telescope is the solar spectroscope. With this in position, the tube is accurately balanced. Weights are then placed on the extension of the declination sleeve until the whole system is in balance. When the solar spectroscope is to be removed, sufficient supplementary weights are placed at the side of the eye end of the tube, so the balance is not disturbed.

The equatorial head and its bearings supporting the polar axis and the entire movable part of the telescope is cast in one piece, its base conforming to the rectangular shape of the column.

The column is 11 by 5 feet at the base, tapering to 10 by 5 feet at the head. It is cast in five sections, having internal flanges for securely bolting it together. In the upper section is placed the driving clock. A spiral staircase at the south side of the column gives easy access to the driving clock, and also to the balcony surrounding the head.

The driving clock is governed by a double conical pendulum, mounted isochronously, and making 60 revolutions per minute.

A driving weight, considerably in excess of the amount required to drive the telescope, is used with this clock, the surplus of power being taken by a friction ring placed just above the pendulum. The arms of the pendulum are so arranged that in operation they always take their natural and theoretical positions, not being swerved therefrom by the action of the power on the friction ring above mentioned. When the clock is unclamped from the polar axis all the power required to move the telescope is instantly transferred to the friction ring, and the pendulum maintains its theoretical position and normal rate. An electric motor is provided for automatically winding the clock.

All clamps and slow motions, both in declination and right ascension, are operated by handles at the eye end within easy reach of the observer, while the assistant on the balcony can also set the telescope in any position and read the circles. In addition, electric motors are provided for operating all quick and slow motions and clamps.

These various motions and clamps being operated by the astronomer at the eye end of the tube either by hand or by means of the electric motors, and also by the assistant on the balcony, are so arranged that any one method of working them is not interfered with by either of the others. Each motion is therefore always ready for action and no conflict is possible.

Incident to the construction of large telescopes, problems are presented in providing domes to cover them, and elevating floors by means of which their use is made more convenient.

These problems have been very satisfactorily solved, for the domes of the best construction will revolve by a direct power of two pounds per ton of weight moved.

Elevating floors of nearly the diameter of the domes are in successful use with the 36-inch Lick telescope and also with the 26-inch telescope at the new Naval Observatory at Washington. Both these elevating floors are operated by hydraulic power, the simple movement of a lever sufficing to raise or lower them.

EXHIBIT OF THE UNITED STATES COAST AND GEODETIC SURVEY.

In common with all maritime nations, the United States follows the wise and beneficent policy of obtaining a full and complete knowledge of its coast, its nature and form, the character of the sea bottom near it, the location of reefs, shoals, and other dangers to navigation, the direction and strength of currents, and the character and amount of magnetic disturbance. Some idea of the importance to this country of such investigations and their extent may be formed when it is remembered that the shore line of the United States, as surveyed, includes 30,000 miles, not counting Alaska, which is several times as extensive.

The United States Coast and Geodetic Survey, established as a bureau under the Secretary of the Treasury, is the organization charged with the collection, compilation, and publication of this information.

PUBLICATIONS.

Forming part of the exhibit, the 500 different charts which it publishes present a condensed summary of investigations conducted in the field by a body of trained experts. These are supplemented by printed tide tables for all the principal and many minor ports; a monthly edition of 10,000 copies of a circular known as "Notices to Mariners," containing notes of all the changes along the coast; Coast Pilots, containing minute directions for all navigable waters along our coasts; and the Report of the Coast and Geodetic Survey, which contains, besides the reports of the Superintendent and his assistants on the conduct of the work, a series of special reports upon various technical and scientific operations of the Service.

FIELD OPERATIONS.

The fieldwork of the Survey consists of a number of operations, geodetic in their nature. A system of primary triangulation, together with the determination of geographical positions by means of astronomical methods, furnishes the foundation upon which the whole rests. This

system controls the work upon the Atlantic, Pacific, and Gulf coasts. It is being extended into the interior and across the continent, so as to form a rigid connection between the great systems of either coast, and at the same time to furnish the various States geographical positions and distances, determined by the most exact methods on which to base their surveys.

BASE MEASURES.

The measured base might well be termed the corner stone of this foundation, since on its accuracy depends the precision of all the distances determined from the horizontal angles observed at the vertices of the triangles forming the system. Several types of base apparatus are exhibited, but attention is especially directed to the Iced Bar apparatus, both on account of its novelty and the attainment by its use of a higher degree of accuracy than any hitherto known. The bar lies in a trough, and when in use is surrounded by crushed ice, thus getting rid of all temperature corrections, which have always proved a source of weakness in all base apparatus. The probable error of the result obtained by this means is less than one five-millionth of the distance measured.

Another novel type is the Duplex apparatus. In each of the two tubes of this apparatus there are two bars of nearly equal length, one of steel and one of brass. They are so arranged that the measurement may be conducted with and expressed in terms of either component. The difference between the measured lengths as expressed by the two components affords a measure of the average temperature of either component during the measure.

TRIANGULATION AND ASTRONOMY.

The various instruments used in conducting the primary triangulations, both for the measure of horizontal angles and for astronomical work are exhibited, among which are two types of instruments for the determination of latitude by the Talcott method, a method which owes its development to the Survey. There is also shown the arrangement of a field station for the determination of longitude by telegraph, or the "American method," so called on account of its being first conceived and practiced by the Survey.

TOPOGRAPHY.

The topographical work of the Survey is illustrated by the display of relief models, original field sheets, and the instruments used in their production; notably the plane table, which has been constantly improved since the first introduction into the Survey, and which has been found to be most effective in nearly all classes of work.

HYDROGRAPHY.

The hydrographic work of the Survey is displayed aboard the steamer *Blake*, which is completely fitted for all kinds of hydrographic operations, and is on exhibition at the water front of the Exposition. One of the features aboard the *Blake* is the Sigsbee machine for deep-sea soundings, with which depths have been recorded of over 4,500 fathoms. Also the novel device by means of which she anchored while investigating the currents of the Gulf Stream, in a depth of over 2 miles.

TIDES AND CURRENTS.

On account of the importance of a knowledge of the tides and currents along our coast the Survey has given much attention to their study. Some of the methods pursued and results obtained are indicated by the exhibits, among which is the tidal model, which shows by means of a miniature representation of the actual process how the tides are automatically recorded; a full-sized self-registering gauge; tide-predicting machine; volumes of tide tables for a thousand ports and stations, and several types of current meters for automatically registering the velocity and direction of the currents.

MAGNETICS.

It has been necessary for the Survey to determine the magnetic elements at many widely distributed points throughout our territory in order to furnish mariners, civil engineers, and surveyors reliable information on this subject. The portion of the exhibit devoted to terrestrial magnetism includes instruments for the determination of its component forces, such as the declinometer, the magnetometer, and the dip circle; two globes 1 meter in diameter on which are show the magnetic curves, and numerous tables and charts indicating the variation of the needle for many localities.

Gravity.—The measurement of the force of gravity by means of the pendulum is not only of scientific and practical interest in its relation to the figure of the earth, but is also of importance in connection with the adjustment of a system of primary triangulation. At present, owing to the local deflection of the plumb line, discrepancies occur between the astronomical and geodetic determinations of points on the earth's surface. With more data from this source it is confidently expected that certain formulas will be derived, which when applied will reconcile the apparent differences between these two methods. In 1890 a complete departure was made in the Survey regarding the form of instrument and the method of observation. A small pendulum, one-fourth the length of the previous one, was constructed as designed by Dr. Mendenhall, and an elegant method, also suggested by him, permits the work being done with numerous advantages over

the older methods. The support is entirely free from flexure, the swinging is done in a closed chamber protected from currents of air and rapid change of temperature, the observations are easily made, the pendulums are very portable, and the accuracy attained is far superior to any hitherto reached. Unfortunately, owing to the exigencies of field work, the only portion of this novel apparatus which could be spared for the exhibit was the pendulum. Photographs which accompany it, however, may give some idea of the receiver, the flash-light device, and the general arrangement of the apparatus when in operation.

Hypsometry.—The necessity of the Survey for a more precise method of leveling in connection with the other geodetic work has resulted in a special form of instrument, one of which is exhibited.

MODEL OF UNITED STATES AND ALASKA.

In order to show in a graphic manner the nature and scope of some of the operations of the Survey, and at the same time to present to those interested in the geography of our country a clearer idea of its true proportions, a model was constructed of the United States and Alaska, as if they were cut out from a sphere about 42 feet in diameter. The various dimensions of the physical features shown on its surface are thus diminished to one-millionth their natural size. This model is in relief, but contrary to the usual custom in making relief maps the vertical scale adopted is the same as that for horizontal distances. It is believed that it will serve to correct some erroneous impressions entertained by those whose knowledge of the earth's surface has been derived from customary sources, where owing to the exaggeration of the vertical scale an exalted notion is obtained of the height and mass of mountain chains utterly out of proportion to the expanse of territory in which they are situated. It will serve also to emphasize the symmetry of the curve of the earth's surface—a curve of such magnitude that mountains and valleys merely roughen the smoothness of its line.

ARTISTIC IRONWORK.

BY

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The exhibit in these two classes was large and varied. There were regrettable gaps, as, for instance, in the British department, where examples of the clever handicraft of English art iron workers were entirely lacking; but, on the whole, the exhibit was very satisfactory both as to the number of pieces and the high class of workmanship displayed. One fact was made conspicuous, viz, that America needs no longer to look to Europe for her supplies of art ironwork. Despite the much to be regretted abstention of several esteemed workers, the fact that since the Centennial Exhibition of 1876 the United States have made a giant's leap in this direction is made evident by the productions of the few who answered the call of the Columbian Exposition managers.

Iron was known in the remotest antiquity, since it has been found in the pyramid of Cheops, where it was used as dowel pins to hold stones together. Such a pin of iron was found under Cleopatra's needle now in Central Park; it was of a steely nature, containing 0.52 per cent carbon, but remarkably pure otherwise. The Romans used iron in their monuments as pins and clamps, while the Gauls, long before the Roman invasion, made ornaments and weapons of it. They may be said to be the first art workers in iron in the West. But the modes of manufacture were such that no great mass could be produced, for if we except the great iron pillars of Kutub, India,* we find no heavy work in iron until we reach a comparatively recent date. Very simple window guards, consisting of one or two bars hammered into crudely ornamental shapes, are first met. A few of these specimens older than the tenth century are still extant, but it is not until a century later that what may really be called an artistic piece of ironwork is found. Viollet-le-Duc states that the oldest ornamental iron grille is now in a church at Puy en Velay, France. It is a simple but strong arrangement of scroll work, made of square hammered bars, finished on the

*This pillar is 23 feet 8 inches high, 16.4 inches diameter at the base and a little more than 12 inches at the top. It has a molded base and capital and weighs over 6 tons. Fergusson says it dates from the end of the fourth century A. D. Later observers have assigned to it a greater antiquity. It is impossible to understand how such a mass was produced with the means at hand.

surface with marks of a blunt-nosed tool. From this time on the art of working iron into ornamental figures for railings and other purposes progressed rapidly until in the middle of the thirteenth century it reached a stage of development which may have been equaled but never surpassed. The workers of that time handled iron in a straightforward manner which puts to shame some of our latter-day workmen, whose effort seems to be to conceal the nature of the material they are treating by adopting fanciful and overloaded forms quite out of keeping with the rugged rigidity of iron. The mediæval workman is not a deceiver; he does not condescend to a mere imitation of nature, he conventionalizes his leaves, his flowers; he uses them sparingly, only as terminals for his strong branch work, and when his task is done the result has the boldness, the crispness of an artist's sketch. In fact, in mediæval times such details of ornamentation were artists' sketches. The design sprung in the head of the man who executed it. He was not a mere workman who fumblingly tried to follow a draftsman's full-sized drawing or a clay model; each curve of the scroll, each leaf, each flower was the expression of a personal feeling. This, probably, is an explanation of the fact that while the sight of some great modern impersonal work—if I may be allowed to call it so—leaves us indifferent and gives us simply an impression of size, we stand delighted before a mere hinge of the thirteenth century. We possess fine specimens belonging to this period. The railings in Westminster Abbey and in the Church of St. Denis and the great hinges of Notre Dame of Paris are conspicuous examples.

The art of working iron into fanciful shapes for public and private uses seems to have spread rapidly throughout Europe, and from the twelfth century on the craft becomes an important one. None of the works are ponderous; iron is not yet obtained in large masses, but it is utilized for many purposes; window guards, altar and choir railings, well fixtures, signs, weather vanes, hinges, bolts, locks, etc., are found everywhere, and as time goes by the production becomes greater and greater. The same spirit of loyalty to the material is observable in the designs up to the middle of the seventeenth century. New devices are introduced, such as heads of fanciful animals, but the leaf and flower ornamentation remains conventional. To that flourishing period belongs the railing of Maximilian's tomb, at Innsbrück. The National Bavarian Museum is rich in models of that age, and so are the Cluny and Kensington museums. Scroll work remains the main feature of the general design, but it is noticeable that the simplicity, to rigid straightforwardness of the earlier period is no longer strictly adhered to. The material is twisted into more difficult shapes, sometimes presenting enormous difficulties in execution. Yet the convention rules in iron work long after the Renaissance had swept aside the older styles in Europe. France, Germany, England, Italy

abound in very fine work of the sixteenth and seventeenth centuries which still breathes the old spirit. At the end of the seventeenth century the workman, no longer a designer as well, urged on by the requirements of a more florid style, becomes too clever, and the architect makes a wrong use of this cleverness by causing him to imitate nature. Leaves and flowers are deconventionalized, works of greater dimension, made easier by improved methods of making iron, are undertaken where mass and details do not always sustain proper relations, and iron is put to illegitimate uses, inasmuch as it is made to take the place of the more plastic metals, and wood, even.

It is not meant here to condemn all artistic iron work made after the latter end of the seventeenth century, for the period has given us wonderful examples which can not be praised too highly. The grille in the Galerie d'Apollon in the Louvre, the door of the Belvedere at Vienna, the Bérain railing in the church of St. Gervais in Paris, the railing of Place Stanislaus in Nancy, the beautiful smaller iron fittings of the period, and many other pieces stand to refute the ultra mediævalists. It is true, however, that the Renaissance, and especially its developments in the eighteenth century, has opened the door for mere imitation iron work, and has also given birth to a lifeless conventionalism which gradually led to the degredation of the art, from which it has been redeemed only through the most strenuous efforts of the best artists and architects in Europe and America.

Some of the examples found in the Columbian Exposition lead one to fear that the eighteenth century has too great a part in inspiring the modern worker. Much of the work is florid to a degree. This is a pitfall from which we will do well to keep away. The door hinges of Notre Dame and the altar rail of St. Ulrich at Augsburg are safer guides than the grille from Würzburg in the National Bavarian Museum. Iron made into nosegays of delicate flowers is like Hercules at the spinning wheel—out of place.

Germany's display was the most important in point of number of individual exhibits and size of pieces exhibited. The workmanship is generally good, and in some cases exceptionally so. The designs seem to be dominated by the eighteenth century spirit. The influence of the style developed under Louis XIV and his successors is visible in all the major works, while in some of the smaller ones we rejoice to find the inspiration coming from more indigenous sources.

The most conspicuous example in the German section was the great gate to the German court, by Armbrüster Brothers, of Frankfort-on-the-Main. The design was intricate and florid, though probably not more so than might be expected in the piece made for exhibition purposes. The flower and leaf work are strong and executed in the right spirit, the whole being done with hammer and chisel, not a particle of cast and dye work being used in the construction of these gates. There

was a certain ruggedness in the general workmanship which might have been toned down without injury to the result, but, on the whole, the production was highly commendable.

In addition to these gates, Armbrüster Brothers exhibited a large number of specimens of their work, showing high-class workmanship at the forge in the treatment of the most intricate flower and leaf work. Two large brackets, unpainted, just as they came out of the hand of the smith, are conspicuous. Also, a very florid balcony railing (gilded all over, alas!), and many minor pieces such as small brackets, candelabras, mirror frames, wreaths, etc., all evidences of good and honest workmanship.

Franz Brechenmacher, of Frankfort-on-the-Main, had at the entrance of the German section of the mines building a very good, large park gate, highly ornamental in design, the flower and leaf work executed in the strong, somewhat rugged manner which characterizes all the German larger pieces in the Exposition. The general effect was fine.

Edward Puls, of Berlin, brought a gate placed at the entrance of the Bavarian south room, and the railings and gates to the south loggias in the main court of the German section. In general design there was an attempt to break away from accepted models. The ornamentation was profuse, and especially in the loggia railings, but, although the introduction of bronze leaf work may not have produced as happy an effect as was expected, the general appearance was very satisfactory. The workmanship was good, and some specially difficult assembled pieces, like the balusters, showed great skill.

F. Bühler & Son, of Offenburg, executed the gates to the north loggias to the German court from an eighteenth century design furnished by the Baden Art School. Stout leaf work, difficult in execution, was the principal feature. We again find a certain ruggedness in this work, but the same firm shows a screen of a similar design, in the Baden Niche outside the court, where the leaves in the frame are much more highly finished.

Max. Marcus, of Berlin, had a high-grade exhibit of smaller art ironwork. In an ornamental case made of iron and plate glass made by him he exhibited several highly finished small objects, such as a clock, some candelabra and candlesticks, an ostrich egg mounted and ornamented in seventeenth century style, etc. The work is almost as fine as that of the silversmith, the surfaces being smoothed and emery-finished after the hammer has done its work. The same exhibitor had several brackets and lamps, as well as a pair of andirons of very good designs and finish. The collection as a whole deserves high praise.

R. Kirsch, of Munich, had a varied exhibit of lamp-posts, lamps, lanterns, chandeliers for gas and electricity, etc. The designs were satisfactory and the execution good A chimney garniture of clock and candelabra showed high finish. A highly ornamental bell pull with

capital leaf and flower ornament was also noticeable. Probably the best piece in the exhibit was the ornamentation of the fire front of the same chimney, conceived in true mediæval spirit.

Among the remaining smaller exhibits several pieces were worthy of mention. A very good seventeenth century door knocker by F. Kracklauer, of Munich; a renaissance casket by Fred Kayser, of Leipsic; some good flowers by G. Stumpf, of Munich; a repoussé iron portrait with florid iron frame, by Peter Liebig, of Munich, which just missed being entirely satisfactory by the evidence of hurried work; two lamp-posts, by Carl Köckert, of Dessau, too florid in design but of good workmanship.

Two manufacturers of ornamental ironwork, Peter Koelbl & Son and Robert Schmidt & Co., both of Munich, exhibit a large variety of smaller articles, such as candlesticks, lamps, and lamp brackets, lanterns, household ornaments, etc. These exhibitors are styled manufacturers, because their wares are more strictly commercial than artistic and are made in large quantities to supply a cheap article. Despite the low price the manufactures are of very fair quality.

Another branch of manufacture in the class of ornamental ironwork calls our attention. Mannstaedt & Co., of Kalk, had a large exhibit of rolled ornamental and plain iron moldings for door and window jambs, window sashes, hand rails, posts, etc. They also exhibited a variety of ornamental drop forgings and stamped ornaments to be used in the current manufacture of fancy railings.

Val. Hammeran, of Frankfort-on-the-Main, had a similar exhibit, the manufacture in this case being confined to ornamental elements for all sorts of fancy ironwork. The greater part of these elements were stamped, but art forgings, ready to incorporate into any work, were also shown. Among these were fantastic heads drawn out of the solid bar and some flowers and branches worthy of the highest praise. They certainly were executed by a man who understood the nature of the material and knew how to avoid the pitfall of lifeless imitation. They may justly be classed among the very best in the Exposition.

Austria sent several characteristic exhibits. As in other departments of modern ornamentation in that country, there is in ironwork an evident endeavor to find new designs. The result is not always entirely satisfactory, but the effort should be duly recognized. As to workmanship, it is generally smoother than that found in German examples.

Albert Mildé, of Vienna, exhibited a large number of objects finished in a very careful and smooth manner. There were examples of railings, lamps and posts, candelabra, etc., and a very good mirror frame of intricate design. Two repoussé heads were more successful than such things usually are when done in iron, which seems to have its shortcomings in the representation of the human figure and face.

strong leaders—Richardson, for instance, whose designs for ironwork are marvels of strength and taste—have reached a stage of development which makes them the peers of their most advanced European competitors.

The Winslow Brothers, of Chicago, though cramped for room, made a display worthy of great praise. Both in design and workmanship the works exposed were such as to show study and care, the result being highly satisfactory. The main piece in this exhibit was a large double park gate. The design was florid, but an effort had evidently been made to fit it to the material, so that the effect produced was in no way weak. The flower work was strong though smoothly executed, and all details of a practical nature, such as welds, and the assembling of parts, were done with a care which showed that with this firm the rules are that no part of the work shall be neglected. An excellent intricate bracket of forged leaf and flower work, and some detached forged flowers strongly executed were also on exhibition. A large number of samples of grilles, stair railings, etc., were also exhibited. They show the same care and workmanship and a great variety of very good designs. All the artistic ironwork exhibited was coated with black magnetic oxide by the Bower-Barff process. This coating preserved the iron from rusting and imparts to it a deep black color with a subdued polished effect, much pleasanter to the eye than the mixture of asphaltum and lampblack sometimes used for painting art ironwork. In addition to ironwork proper, the same firm exhibited a variety of articles obtained by the galvanoplastic process of electro-deposition. This is an important process, for not only can small reproductions be made, such as bas-reliefs, etc., but also more important pieces to be used in large architectural decoration and construction. A handsome chimney piece made in this manner was shown, as well as samples of newel posts and stair railings. An application of the process of electro-deposition on wood was shown in the shape of spindles and bars for elevator inclosures. A thick coat of copper was deposited upon the turned wood spindle, giving to it the appearance of brass and adding materially to its strength. A large screen of coarse lace, coated with copper by electro-deposition, was also on exhibition. A section of ornamental railings of cast aluminum was among the exhibits.

Bayer & Sherbner, of New York, exhibited several pieces of well-made ironwork. A pair of monumental andirons were noticeable for the strength of the design and careful workmanship. A very fine fire-screen, with florid iron frame and beaten copper center, showed good handling of complicated leaf form.

This firm also exhibited a very ingenious system of folding iron gate for elevators and store entrances.

Paul Seidl, of Chicago, had an exhibition of smaller art iron articles. There were candlesticks and candelabras, wall brackets, lanterns,

etc., showing clever and good work. A large and very florid cross was also exhibited. The designs were generally quite florid, and difficulties of execution were created which, if left out, might have improved the result. In all the examples the work was conscientiously done. The same exhibitor had a very well-executed piece of repoussé iron work in the shape of an ornamental coat of arms.

F. Hainsworth & Son, of Chicago, exhibited some plain scroll grille work, and E. T. Barnum, of Detroit, had a variety of very neatly executed examples of gratings and railings for banks, offices, and other interior work. They were made in plain scroll patterns, plated hoop iron, twisted bars, and other plain devices.

IVORY AND WOOD CARVINGS, ETC.

BY

ALBERT H. DAINTY.

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IVORY AND WOOD CARVINGS, ETC.

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IVORY CARVINGS.

The perpetuation of this prehistoric and very ancient art, as exemplified by the displays in this Exposition, should be most gratifying to those who love art for art itself, and most interesting and instructive to those who naturally love the beautiful. The exhibits in ivory carving exceeded in number and general excellence those shown at the International Exposition held at Philadelphia in 1876, and the Universal Exposition held at Paris in 1889. Upon reviewing in detail the exhibits, out of courtesy to great age and reputation, I naturally write first of the Chinese and Japanese collections. Owing, perhaps, to the unofficial recognition of the Exposition by the Chinese Government, the display made by this country was somewhat limited, and not, as a whole, up to the standard of what, as a nation, China could have shown. The collection which was exhibited was in the name of Chun Quan Kee, an enterprising Canton merchant. The most excellent piece which he submitted was a tusk, deeply and richly carved, representing different periods of Chinese dynasty. The tusk was gracefully poised, and rested upon a base of ornately carved wood. This, with the remainder of the collection, consisting of flower boats, jewel caskets, vases, chessmen, etc., showed that in technique this race has lost none of its reputation in ivory carving, for which it has so long been noted.

With the Japanese, however, officially and enthusiastically recognizing our Exposition, the result was quite different, both in ivory and wood carving—not in the great number, but in the artistic excellence of the pieces submitted. As in her fine-arts display, Japan only allowed the best to be sent. Notably among these there were shown in the fine-arts building "The Goddess of Mercy," by Mitsuaki Ishiwaka, a statue most exquisitely modeled and most delicately carved; and "A Great Japanese Thinker," carved in rosewood, in his hands an ivory skull, wonderfully expressive and finely cut. The rosewood in this piece was carved by Ashai Eizo Okiska, the skull by Gyakzan Asahi. Japan also added one tribute by a woman, Mrs. Yaye Kikuma, "An Image of a Child," holding in its arms a rooster and looking

upon a hen upon the ground. This piece was artistic in its composition and well carved. It was exhibited in the woman's building. In the manufactures and liberal arts building there were many pieces exhibited by different artists of Tokyo, Osaka, and Kanagawa, all showing progression in this art—if that were possible—and again confirming the fact that Japanese ivory carvings are yet preeminent for originality of design and delicacy of cutting.

India, through native Bombay merchants, exhibited ivory figures and boxes more commercial than artistic in value.

Ceylon sent a collection of elephant tusks supported upon carved ebony bases; carved ivory elephants in miniature; an ivory jewel casket ornamented with pure gold and precious stones, beautifully carved in conventional oriental forms; an ancient "Almyrah," or cabinet, restored, which was most unique in construction and ornamentation; also smaller pieces of minor interest.

Siam, in her first offering to an American Exposition, presented an excellent display of native ivory tusks and a small but unique collection of carvings, the piece de resistance being a tusk deeply carved with repeated reproductions of Budha, diminishing in size as the tusk grew smaller.

Austria only exhibited small and commercial pieces in ivory carving.

France, whose interest seems to be bronze for metal chiseling and wood for a more yielding substance, sent but one piece of ivory carving. This was an ancient piece, subject, "Venus," artist unknown. It was a most artistic model, well executed. This piece was exhibited in the French section, woman's building.

Great Britain was solely represented by the Countess of Tankerville with an exhibit of well-executed fan handles and plaques for cardcases. These were exhibited in the woman's building.

Germany, however, should be given the fullest credit for the ivory carvings displayed by her exhibitors. The fixed purpose of her young Emperor William to excel must have inspired her artists in this direction. As a result they sent to us not only the greatest number but the most beautiful of all modern pieces. It would seem that Anton Diessl, of Munich, had nearly reached the zenith attained by artists of the sixteenth century by his "Christ upon the Cross," so full of expression; his "Statue of the Meleagrus," so artistically modeled and carved; his "Bacchus and Cupid Tankard," and a "Mirror Frame," cut in rococo ornamentation, both exquisite in composition and ornamentation, and his most faithful "Reproduction of a Quill," so thinly carved as to be almost transparent, and showing a delicacy of cutting that amazed even the Japanese experts who viewed it.

The elaborate and artistic exhibit of Moritz Keller & Co., of Berlin, included two ornate pieces, one a sled, after the splendid renaissance sled of King Ludwig II, of Bavaria; the other, a reproduction of the ship Ste. Marguerite, the original of which was carved for the Queen

of Italy. This was in rococo ornamentation, the subject being symbolical of the different stages of life.

The single exhibit of ivory carving by the United States was by the Tiffany Glass and Decorating Company, of New York, while Messrs. Tiffany & Co., of New York, jewelers, exhibited small ivory tusks mounted with silver supports and ornaments. The Brunswick-Balke-Collender Company, of Chicago, exhibited a most unique and interesting collection of large ivory tusks.

Ecuador exhibited ivory work done by her penitentiary prisoners; also ivory eggs in openwork.

No other countries displayed ivory carving, and no additional exhibits were needed to emphasize the statement made by one of the best European judges, that "The World's Columbian Exposition contained the most elaborate and finest display of ivory carvings ever exhibited at any international exposition, and not to be eclipsed except by the museum collections of Europe."

It is fair to presume that in the art of ivory carving, owing to the absence of reference collections in museums and the higher cost of labor, America will never be able to obtain any great prominence, although out of her great wealth her citizens and museums may secure valuable collections of this art.

May we not infer from the marked and progressive advancement in the price of ivory, its greater demand for commercial use, and the rapid extinction of the ivory-bearing animals that in the future the art of ivory carving will be comparatively lost, only to remain in the creations of the past?

WOOD CARVINGS.

Rising to the height of 40 feet in front of the houses of the Fort Rupert Indians, skirting the shore of the south pond, there stood rudely carved totem poles. Between these and the statuettes 1½ inches high, nestling safely in a glass case in the Columbia State building, there was a range of wood carvings attracted to the World's Columbian Exposition that in variety has never been surpassed, and may never be again, showing the progression in this art.

In the ethnological building there were exhibited miniature reproductions of Haidas houses, with carved and painted totem poles in front of each, many implements of war and useful articles made by the American Indians and ornamented by characteristic carvings. From the South Sea Islands, battle shields and instruments of war; also useful utensils, showing carving done with stone implements and crudely sculptured images. From the Solomon Islands, grotesquely carved sun gods. From Old Mexico, taken from the churches, there were shown religious relievo panels and deeply carved columns in the ornamentation of the sixteenth century; also the reproduction of an ancient temple showing architectural sculpture carved in wood. From Brazil,

carved cedar angelic images, with hinged openings in the back, in which it is supposed the priests secreted themselves while they spoke to their superstitious worshipers.

Upon the Midway Plaisance there were exhibited curios in wood, with more or less carving upon them, from Dahomey, the North American Indians, East India, the Soudan, Algiers, Turkey, and Java; also an interesting collection of bogwood carvings from Ireland in Celtic designs.

Reviewing the exhibits of more artistic and modern wood carving, I have to report that New South Wales sent nothing in sculpture except as applied to the ornament of furniture. These examples were few, the best designs being adapted from their own flora, and well executed.

The Chinese exhibited a few pieces of carved sandalwood and a small collection of blackwood furniture and screens, moderately ornamented and well carved in characteristic designs.

Japan, as in ivory, contributed only the "survival of the fittest," in the fine arts building showing "The Wrestler," a typical representative of this ancient Japanese pastime, and a "Military Procession in the Olden Time," carved in a high-relief panel, both by the artist Kissai Yamada. The posing, grouping, and carving in these pieces showed a superlative result. Japan also displayed in the manufactures and liberal arts building about fifty examples by many artists, mostly of a high order, special mention being made of "The Attack of a Prince," by Toyo Aikawa, a deeply carved panel 10 by 14 inches, showing the forest, the roadway, and the attack, with frightened birds flying away through the trees. This piece required four years' time to complete and was most delicate in its composition and in its carving. Also "A Skull with Snake," by M. Idzumi; screen representing a hermit, by K. Nosui; carved and painted "Japanese Women," by F. & T. Nakatani; "Buddha in Miniature," by G. Hompo; but most remarkable of all, Japan showed in the liberal arts a large panel with carved eagle, done at the Tokyo School for the Blind.

Turkey in her state pavilion showed a revival of this art in work done upon a bookcase by the students of the Imperial Ottoman Arsenal, Constantinople, and in the same building the province of Syria displayed a few simple commercial pieces.

Egypt, in the name of the Technical School of Cairo, showed in the liberal arts carved panels and architectural details, evidencing a revival of this art in this most ancient city.

Ceylon in her state building, supplemented by the "courts of honor" she erected in each of the three buildings, viz, manufactures, agricultural, and woman's, may be said to have made an exhaustive display of what Ceylon can do in wood carving. Her state building, viewed from the exterior, revealed a highly carved stairway and balustrade overshadowed by scrolls, foilage, and "gnomes," richly carved,

and flanked on either side by ornately carved window architraves and panels with symbolical reproductions. The interior presented a wealth of pillars and panels in various beautiful woods of Ceylon carved in conventional forms of the lotus and plantain. In the central "court of honor" carved ebony elephants kept watchful guard under their glass cages, while a forest of tusks, artistically placed and rising from carved ebony bases, gave an oriental dignity and charm which the visitor will long remember. The description of the Ceylon courts, published by H. C. Cottle, government printer, Ceylon, Colombo, which was sold at the various exhibits of Ceylon, is referred to for a fuller description of these carvings.

From India, the parent of Renaissance art, there was sent by an American artist, Mr. Lockwood de Forest, a carved teak-wood house representing the pure ancient decorative forms, beautifully executed. This house, with its furniture, proved to be one of the attractive exhibits in the manfactures building. There were also shown in this building, by native Indian merchants, furniture in teak, jewel caskets, and various ornaments in sandalwood, all executed in the high standard of this country.

Russia in the fine-arts building contributed by Adamson two wood sculptures—one, "The Helpless," an artistic composition delicately treated, the other, "The Dying Hyacinthe," exquisitely cut and finished. In the manufactures building the carving by Lovigton and De Kamilly, as applied to furniture, is worthy of special mention. There was also displayed in the liberal arts, in the name of the School of the Imperial Society for the Promotion of Art and the Central School of Baron Stieglif, wood carvings on panels, boxes, screens, and furniture, in artistic designs, showing meritorious technical skill.

Norway, though not competing for awards, exhibited in drinking horns, tankards, and boxes most artistic examples, clean and crisply cut, in well-defined Norse designs, the work of Lars T. Kinservik and Magnus M. Dagestad being preeminently well done.

Sweden, in the display of Swedish art industry, by Miss Gioebel, of Stockholm, exhibited characteristic carvings in tankards, boxes, furniture, etc., artistic in design and most clearly defined in cutting. In the exhibit of the Swedish Industrial Art Society, of Stockholm, the great value of this society's influence was demonstrated in the carving submitted. The highest praise should be given for the sculpture of Christian Eriksson, as giving a quite new artistic effect, obtained by appliance of realistic sculpture for ornamental purposes, and the excellent carvings by L. O. Lofmark and C. O. Johanson; all of these were in the Swedish state building. In the fine-arts building "A Statue of the Artist's Grandmother," by And. L. Zorn, was a most touching and beautiful example of wood sculpture.

Denmark sent a few pieces of distinctive wood carving by A. Ingemann Olsen, consisting of leaf of burdock with flowers, a lid for

a box, and a palette with foliage, all exceedingly well carved in high relief from solid wood. In the furniture exhibited there were many excellent carvings, notably panels shown on two wardrobes, the larger representing scenes in the history of King Ahasuerus and Queen Esther, the smaller representing the flight into Egypt of Joseph and Mary; also ornamental carvings by the Baroness Ursula Dahlerupe applied to a cradle made for Baby Ruth, the daughter of President Cleveland. This was displayed in the woman's building.

Switzerland—to Americans the name represents wood carvings, or what we call Swiss carvings. These were exhibited in great profusion, mostly in characteristic subjects, as groups of horses, cattle, and chamois, also eagles and clocks; a few notable departures from these being a chastely carved example of Italian Renaissance cabinet by Ernest Roggero; a panel representing a vase of flowers, most delicately carved in high relief by Jakob Abplanalp; also an ambitious sculptured group, "The Meeting of the Poachers and the Game Keepers," by Chr. Zumbrumm. The Society for the Industry of Sculpture also exhibited many meritorious pieces, among them a jewel cabinet carved in marguerites, a group of horses, group of cattle, and dog with puppies, all showing high technical skill, and, in some instances, artistic ability worthy of higher attainments in sculpture.

Italy, prolific in sculpture and carving as an applied art, through Besarel, showed a great number of statues and furniture, modeled and carved with the high excellence for which this artist is noted. Andrea Bacetti revealed the genius of the true artist by the absence of all reproductions in his compositions as represented in his chimney piece and in his library, the front panel of which, carved in florid renaissance, is the largest single piece ever done in Italy. His great technical skill is also shown in a panel of grapes and vines carved in high relief, while his bas-reliefs gave proof of the originality, distinction, and finesse of the master's chisel. There were also exhibits of carvings shown in the figures and furniture in fifteenth and sixteenth century designs, by Antonio Zanetti, Francesco Toso, and Mora Brothers. Italy also displayed in the liberal arts a collection of great merit showing technical work done in the Institute of Arts of Palermo.

Bulgaria's, Spain's, and Austria's exhibits in wood carvings were unimportant in number and execution.

Germany, however, with the spirit that won for her so much merit in this Exposition, sent us masterpieces in wood carving. In the fine arts building, by Prof. E. Herter, of Berlin, there was shown "Moses Destroying the Tables of the Law." In the German State building there was shown by Heinrich Behr the "Lord's Supper" in bas-relief carved from linden wood, remarkable for character modeling, strong expression, and meritorious carving. In the manufactures building Germany was represented in wood carving by many artists—

a marvelously carved altar by L. Vogt, amorettes by Carl Fischer, an Italian renaissance panel by William Klippel, splendid German renaissance designs by Profs. H. Goetz and Rud. Mayer, executed by A. Gherig; delicately carved jewel caskets by H. Maybach and L. Parr, and rococo frames by F. Radspieler & Co., supplemented by the finished collection of technical examples of wood carving submitted by the School for the Education of Artisans of the Grand Dukedom of Baden at Karlsruhe, shown in the liberal arts. All of these, in connection with the many examples of wood carving seen in the display of furniture, demonstrate that this nation, with her industrial education, is fast attaining perfection in the art of wood carving.

Though not competing for award, France, aside from an interesting technical exhibit in the liberal arts by the St. Nicholas Trade School of Paris, exhibited a few wood carvings as applied to furniture. These examples, however, represented the essence, as it were, of this art, and upon a close analysis emphasize the fact that for perfection of drawing and delicacy of clean, finished wood carving France has no superior, while few wood carvers outside of France can even approximate the artistic and finished technique displayed in Quignon's Louis XVI bookcase, his pear-wood table of the same period, or his walnut cabinet in the style of Louis XV.

England was represented in the manufactures building in wood carving by Harry Hems & Sons in church furniture and figures. A notable piece exhibited was "Christ upon the Cross," a most artistic rendition and exceedingly well carved. In the liberal arts England showed carved panels done at the Primary School of London for Deaf-Mutes, also carved panels from the St. Joseph School, Manchester, England. There were many other carvings, mostly reproductions of the Elizabethan and Renaissance schools, done by Johnstone, Norman & Co. in the furnishing of Victoria House, Her Majesty's headquarters; also in the facsimile reproduction of Lord Salisbury's banqueting hall, displayed in the manufactures building by Messrs. Hampton & Sons. There were also shown in the British section, woman's building, many examples of carvings in furniture, panels, etc.

Canada submitted few carvings in wood. The most ambitious piece was by Casper Ostler, of Hamilton College, shown in the liberal arts, a panel about 3 by 5 feet, in one piece, "The Landing of Columbus," in bas-relief.

Ecuador sent a carved representation of a human skull, by Migriel Velez, Cuenca, so treated with color and fungus growth as to almost lead one, even after a critical examination, to pronounce it genuine.

Colombia, in the name of Martinez, exhibited in her State building 12 statuettes 1½ inches high. These, considering the conditions under which they were done, were among the most remarkable wood carvings shown in the entire exhibition. Each figure represented a typical native, costumed according to his or her avocation. The modeling and

carving were done by the daughter, Amelia Martinez, a native peasant girl, 17 years of age, who, without education or art surroundings and with no instrument but an ordinary knife, carved these statuettes so finely, modeled them so correctly, and gave to each so much expression that, under a magnifying glass, one's surprise and appreciation for them were intensified.

Guatemala exhibited, through Juan Ganuza, "The Passion of Christ." an exceptional rendition of this subject.

The Argentine Republic, Costa Rica, and old Mexico only exhibited wood carvings of minor interest.

By the United States there were displayed in the liberal arts technical examples of wood carving by the following schools: Waltham, Mass., public schools; New York Teachers' College; Rensselaer Polytechnic High School, New York; Baron de Hirsch Fund Trade School, New York City; Pratt Institute, New York: Christian Brothers Academy, Albany, N. Y.; New Jersey State Normal; New Jersey School for the Deaf; Pennsylvania Museum and School of Industrial Art; Catholic High School, Philadelphia; J. Liberty Tadd's School for Teachers, Philadelphia; St. Francis Industrial School, Eddington, Pa.; Mount Aloysius, Cresson, Pa.; Ohio Normal School; Toledo, Ohio, Manual Training School; St. Joseph Orphan Home, Columbus, Ohio; Michigan School for the Deaf; Pardue University, Indiana; Epheta School for the Deaf, Chicago; St. Louis Manual Training School; Minnesota public schools, collective exhibit; Minnesota Training School for the Feeble Minded; Minnesota School for the Deaf; Colorado public schools, collective exhibit, and North Dakota schools.

Those deserving of mention for the best results accomplished were: New York Teachers' College, Pennsylvania Museum and School of Industrial Arts, Rensselaer Polytechnic High School, Pratt Institute, St. Joseph's Orphan Home, Columbus, Ohio; Catholic High School, Philadelphia; Epheta School for the Deaf, Chicago.

There were shown in the manufactures building by Sypher & Co., of New York City, reproductions of ancient furniture with ornate carvings, and a woods culptured panel shown by Rud. Lund, Knoxville, Tenn., subject, "World's Fair Greek Structure." This was a very ambitious piece, but poor in execution. There were also some examples of applied carving to interior decorations, furniture, billiard tables, and pianos; all, however, below the standard of excellence attained in European countries.

Without the women, the United States would have been poorly represented in this art. In the woman's building there were displayed many examples of wood carving, mostly in panels, and as applied to furniture. The influence of the Cincinnati School of Design, which made its first efforts and exhibition (mostly by women) at the Philadelphia Exposition, was to be seen in the different pieces

submitted from all parts of the country, many of which showed marked advancement in drawing and technique. Each State contributed, through some one of its native women artists, original and characteristic carved panels. These were placed above the wainscot in the recorder's room, and proved to be most interesting and artistic as a decorative feature. In the Cincinnati room there were displayed many of the pieces of furniture formerly exhibited at Philadelphia, together with recent productions, showing progress in design and execution. In the California room, woman's building, a set of furniture, with carved decorations adapted from the cactus, was displayed. The adaptation was artistic and the carving excellent. The Young Woman's Christian Association of Boston displayed carved chairs and settle in strong Viking design. There were many meritorious individual pieces exhibted—the work of Mrs. M. L. Bentley, Mrs. John Lowell, and Miss S. Blom being worthy of special mention.

In the assembly room occupied by the board of lady managers the "Virginia Dare" desk was displayed and used by the presiding officer, Mrs. Potter Palmer. This desk will be prized for the historic sentiment surrounding it, and also for its recent association. It is ornamented by carved panels of white holly from Roanoke Island, North Carolina, where, in 1587, Virginia Dare, the first white child of English-speaking parents, was born and baptized. The carved panels were executed by a young girl without instruction in this art. On the right front panel is carved the coat of arms of Sir Walter Raleigh; on the left is the pinnace bearing colonists to Roanoke Island; the central front panel represents the coast of the island, the figure of the doe being symbolic of Virginia Dare, whom the Indians, in admiration of her sex and complexion, called "The White Doe," and who, an Indian legend relates, was transformed into a white doe and haunted the island. The end panels represent the Scuppernong grape, found on the island and native to the soil. The desk is a tribute to the memory of Virginia Dare from the women of North Carolina, and was appropriately placed in the room where the first official board of women organized under act of Congress met. An ornately carved chair in rich redwood, furnished by the new State of North Dakota, served as a beautiful contrast and fit companion to this desk.

There were also exhibited in the Illinois State building carvings by the Elgin School for Carvings, and in the Maryland State building, two panels, subjects, "Asia" and "Africa," carved by W. Teubler.

In variety, the wood carvings distributed throughout the World's Columbian Exposition exceeded by far in number and interest those of all previous expositions. Following up the progress evolved between the Sun God of the Solomon Islands and Besarel's statues, I was impressed particularly by the artistic, finished advancement to be attained through technical education, the best results always being

reached when such education is most thorough, as in France and Germany. The United States, in this respect, is yet mediocre; our technical and free art schools are few; our boys are practically shut out by the laws of trade unions from exploiting any native or primarily instructed talent, and our people, generally, are not critical of details, and therefore accept pressed and machine-carved imitations, or indifferently done hand work. We have the opportunity, however, to not only reach a European standard but to excel in this art. Why, then, with native ability and great wealth to aid technical and art schools, should we not create our own art and carve it out in the highest possible state of perfection?

INCISED BAMBOO WORK.

Only two countries exhibited in this work—China and Japan. The number of pieces were few and the subjects and execution unimportant.

CARVINGS IN MISCELLANEOUS MATERIALS.

The United States exhibited pictures carved in cork, the head of a Maori chief carved in gum copal, a reproduction of Bartholdi's Statue of Liberty carved in salt; also carvings in meerschaum, horn, tortoise shell, petrified wood from Arizona, and pipestone from Minnesota.

Vienna made a collective exhibit of meerschaum and pearl shell carvings by the amber turners of Vienna. Italy showed exquisite carvings in tortoise shell. Ceylon displayed carvings in cocoanut shells. New South Wales exhibited carvings in emu eggs. Brazil showed etched and carved gourds, and Trinidad and Guiana showed carvings in calabashes and gourds, those from Trinidad being done by a blind native.

MACHINE-MADE LACES AND CURTAINS.

BY

FRITZ GRAEBER.

MACHINE-MADE LACES AND CURTAINS.

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The great Exposition of 1893 is remarkable not only for the various industries represented, but also for the complete or partial absence of many important branches of manufacture which in former exhibitions belonged to the leading features. Such important centers of manufacture as Manchester, Birmingham, Elberfeld, Barmen, Mülhausen, etc., are without adequate representation, and unfortunately some of the towns producing the articles which form the subject of this report are not exhibiting in a way that is in keeping with their importance. I refer principally to Nottingham, the home of machine-made lace with its hundreds of Lever's and curtain machines, which has sent only one curtain exhibit; and to St. Gall, which would be absent entirely if it was not for one pair of curtains displayed in a hidden place. It is difficult to explain the indifference of these markets in regard to the Fair. Certainly the principal reasons are the high tariff and fear of showing too much of their patterns and novelties to their new competitors in the United States.

The only displays of machine-made lace which call for special attention are those of Calais and Cande in the French section, and of Plauen in the German section. Outside of these two exhibits there is not much machine-made lace shown. Of all other European countries only Spain presents some embroidery laces. Austria, Italy, Russia, and Norway, which have a lace industry of their own, are not represented. Their goods, no doubt, are being made for the home markets only, and can not be exported.

In the United States the making of lace by machinery is still too new an industry, and this fact may account for there being only two exhibitors, although there are many more manufacturers.

Taking now the individual exhibits in the same rotation as the official catalogue the United States exhibits are the first that must be mentioned:

Jennings lace works, Brooklyn, N. Y., show a great variety of lace made on Lever's machines both in silk and cotton. They also exhibit fancy nets. The display is a very fine one, and shows that this firm is already very far advanced in the making of lace goods.

The same can not be said of the other American exhibit—that of Wilkes-Barré, New York. This house shows curtains made on English lace-curtain machines of different gauges (6 to 12 points), mostly single-tie goods, also some bar nets and double actions, but no Swiss work. There are several large stores with pictures, which can not be called a success even if all allowance is made for the difficulty in producing this kind of work on lace machines; also the making of the goods does not seem to be watched as carefully as it ought to be. Several defects are to be seen which have not been mended.

The French exhibits are arranged in collective groups. Calais is represented by the Chambre Syndicale des Fabricants de Tulles et Dentelles Mechaniques. This display is a beautiful one and contains specimens of all the articles a lace machine can make, specially fine and finest goods. The silk laces comprise magnificent Spanish laces, Chantilly laces, some in very large widths, Blondes, Guipures, etc. Frequent use is made of figures which are often very natural.

In cotton laces there are splendid assortments of Valenciennes, Maltese, Duchesse, Bretonnes, Point de Gare, Brabants, and others.

Outside of the exhibit of the Chambre syndicate is that of Davenierè & Co., Limited, Calais, which also is very important and contains some of the finest Chantilly and Spanish laces and flounces that can be made. The Calais exhibits show plainly that the old high standard is well and easily maintained.

Candry is known as a place where lower grades of lace at cheap prices are made, and the exhibit at the Fair confirms this circumstance. Eleven manufacturers show their goods in a uniform display, and although there is a great variety of black blonde laces, Guipure laces, ecru cotton laces, etc., in good patterns and well-made qualities, yet it can easily be noticed that the goods are of quite a different stamp than those shown by Calais.

In the French section there is further an exhibit from Reichenbach & Co., a St. Gall house, which shows some fine flounces and laces made on embroidery machines.

From France we come to Germany. As Elberfeld-Barmen is not exhibiting, there are only Saxon laces. They, however, are shown in a great variety by Plauen firms. They form part of the well-known collective exhibit of textiles from Saxony, and from the beginning of the Fair have commanded general attention.

The Plauen manufacturers excel not only in the articles they show but also in the way the display inside the show cases is made. The goods are not shown in the usual store-window decoration style, but are put up in a more artistic way, each case representing some other idea.

The lace industry of Plauen is a comparatively new one. At the time of the Centennial Exhibition it did not exist yet. The goods are not made on Lever's (bobbin) machines, as in England and France, but

on the embroidery machines. There have been embroidery machines at work at Plauen for over thirty years, but they did not make anything but flat embroideries. Laces on net were first introduced in 1881, and Guipure laces (Luftspitzen), done on the machine on thin wool cloth, which afterwards is eaten away by the finish, were brought out a few years later. The importance of Plauen as an international center of the lace trade does not date further back than the above year.

A great help in developing the making of lace at Plauen was the introduction of the shuttle embroidery machine, which is partially worked by power, while the old hand machine requires hard work by arms and feet. The shuttle machine turns off enormous quantities of lace, while the hand machine is still used where finer and more costly goods are wanted.

The progress made in the short time that lace work has been introduced is very marked, and the goods shown by Wm. Weindler & Co., F. A. Mammen & Co., Wm. Berkling, C. R. Eichhorn, Klemm & Steger, Robert Neubauer Nachf., Tröger & Co., and G. A. Jahn are magnificent, and it is difficult to say which of these firms has really made the finest display.

F. A. Mammen & Co. and Weindler & Co. have among their other articles some remarkable wide black silk flounces; Berkling and Eichhorn excel in cotton goods, the repeats of some of the laces being extraordinarily large, which increases the difficulties of the making considerably.

Some Plauen houses make it a specialty to imitate old real laces, and point à la rose, Duchesse, Venetians, etc., are made so well that only an expert can see they are imitations. Robert Neubauer Nachf., Klemm & Steger, and others cultivate this branch.

By the side of the lace work, the original industry of Plauen, the embroidering on cambric, calico, and other close fabrics is still going on, and there are three fine exhibits in this branch—Schrage & Roessing, who show the embroideries worked already into children's dresses, etc., Gebr. Schindler and Louis Apitrsch, who show the regular flat white embroidery.

Besides laces, Plauen displays his other staple article, curtains, both in the Nottingham lace style and the Tambour make.

The curtains in Nottingham style are shown by Gardinen fabrik Plauen, a joint stock company, which makes goods in all gauges from 5 to 14 points. Some patterns for stores have very long repeats. They also show Swiss goods and Swiss of combination makes. The goods are well made throughout, and the patterns are first-class productions.

The making of these curtains is also a new industry, and was started in 1879–1880. It pushed out the old Broche curtain made on common looms.

Curtains made by Tambour machines, partly in colors, are in the display of Fritz Bergmann, Plauen. His colored goods are unique at the Fair, there being no other house showing such goods. The patterns are very fine and all done by first-class designers.

Quite another class of machine embroideries are the trimmings of Eibenstock. This town makes a collective exhibit, and although a great deal of the goods is handmade, there is quite a nice assortment of machine-made silk trimmings in nice fancy colors. The make of the goods is superior. Six Eibenstock firms make this collective exhibit.

Great Britain, as mentioned before, has only one exhibit of lace curtains, which is all there is to remind us that there is such an important place as Nottingham. The exhibitors are Messrs. S. Peach & Sons, and show specimens of a number of different styles that can be made on curtain machines, including some curtains in silk. The exhibit is a fine one, generally speaking; but it is a pity that the old way of embroidering curtains seems to have been revived.

Spain is represented by one exhibit, that of Torella Hermanos, Barcelona. The goods are made on the shuttle embroidery machine. Those made on cotton are only low in quality, while the silk handkerchiefs in colors are very fine. For Spain this work is a new industry, and special credit is due for it accordingly.

Switzerland had better not made any display at all, instead of send- just one pair of embroidered curtains of the Guipure or "Sporchtel" kind. It is exhibited by Ph. Emden, St. Gall, and, as far as it goes, is a very nice, well-made specimen.

Making a résumé of all the goods shown in this style, a great advancement in the production of lace goods is evident. While seventeen years ago (Philadelphia fair) there were practically only two centers where machine-made lace was made, viz, Nottingham and Calais, we have now lace industries in a number of countries, Germany having come out very prominently, while the United States have laid a good foundation. They will no doubt build up a trade by and by, although in this branch, unlike other industries, the protective tariff will not help much to foster it. A lace industry can only be developed by competent work people who have been brought up to it by degrees.

Machine-made lace has still a great future and will be used more and more in proportion to the well being of the masses.

Let us hope that peace and prosperity will continue to lift up the standard of life in all countries, so that the consumption of this beautiful article will grow constantly and supply work for thousands of industrious hands, both male and female.

LAMPS.

BY

WALTER S. LENOX.

LAMPS.

By W. S. Lenox.

According to the ancient legends Prometheus was the first illuminator. He stole fire from the abode of the gods and brought it to earth, and for this gift to man was thrown out of heaven by the angered deities. So runs the fable—a theme for poets and painters for many thousand years. But the matter-of-fact scientist tells us that primeval man went to bed at sunset, and, as he lived on herbs and fruits, a fire for cooking was unnecessary. Yet, in the mute and swallow-like homes of the Cliff Dwellers, in the oldest of Egyptian tombs, among the most ancient remains of early Greece and Rome, embalmed in the history and legend alike of the Hindoo and Chinese, and even in the Book of Books itself, we are constantly confronted with a lamp. So faulty and vague are the evidences that it is impossible to note the line of departure, that point where man ceased to use a pine torch, or whatever barbarous contrivance he may have invented, and evolved the lamp. But of this we may be sure—it is one of the most ancient methods of artificial light known to man. The lamp in some form or other continually appears and reappears in all the countless changes of history and story through many centuries, and no article of ancient manufacture is more common. They are found in every variety of form and size, in clay and metal, of the cheapest as well as of the most costly description. Their invention is ascribed to the Egyptians, by whom the external form received more attention than its usefulness as a light giver. Some of those taken from ancient tombs and buried cities are marvels of exquisite workmanship, and it is a curious historical fact that there was very little change in their evolution from the most ancient times until a period as recent as a century and a half ago. Artistic taste had been shown in design, but all improvement stopped at form and decoration.

In 1782 Argand invented a burner with a circular wick, and after this forms and modifications of his invention have been numerous. Oil lamps have been supplemented by gas, natural and artificial. The first practical attempt at gas lighting was made in 1792 in England; adopted in Paris in 1802, and in the United States in 1806, at Newport,

R. I., and within the last decade Edison and Swan, at the head of many experimenters in the subtle fluid, have revolutionized our lighting system by the practical application of electricity for all lighting and heating purposes.

The lamp exhibit of the World's Columbian Exposition contains examples of invention and progress in all. We would like to have seen a more extended and representative display, but the collection as it stands is a meritorious one in many respects, and we feel convinced that the exhibits in this group will be beneficial as educators in the application of scientific principles and decorative art; and whatever in the realm of utility or beauty makes our homes more attractive and interesting assists in social, moral, and national progress. England, France, Belgium, Russia, Germany, Austria, Sweden, Spain, Italy, and the Argentine Republic have brought us specimens of their workmanship, and our own manufacturers are well represented. There could be no competitive comparison, as each exhibit belongs to a class of its own. There is a great deal from abroad that is instructive and valuable, and the demand for refined and luxurious forms has been met by artistic and scientific effort; a high grade of workmanship is everywhere apparent, numerous patent appliances and appurtenances show an effort toward future improvement, and each class suggests an individual line of development.

Our own country stands well to the front in all grades of manufacture, and the extraordinary inventive activity by which we are characterized is evident in good results.

Included in the group are lamps for burning petroleum of various grades, together with burners, chimneys, and shades. Upon many of these the most artistic taste has been lavished in superior designing, modeling, and decoration. Superior materials have been employed in articles for domestic use; the most precious and costly have been combined to produce beautiful and effective decorations. Lanterns, coach lamps, street and special lights and lanterns are shown in examples of honest construction and durable use. Illuminating gas, natural and artificial, has had its principle of economical utility and comfort demonstrated, together with burners, fixtures, and chandeliers remarkable for invention and beauty. Electroliers and the electric lamps surprise and delight the multitude at many points.

It has been pleasing to behold the general excellence of the exhibits and the good taste displayed in their arrangement as to originality, convenience, and beauty. Strict values and a high standard have been maintained throughout.

LIQUORS.

BEER: HISTORY AND ADVANCEMENT OF THE ART OF BREWING.

By EUGENE F. WEIGEL.

ANTIQUITY OF BEER.

Beer in our generation has almost become one of the necessities of life, and it is certainly true that among civilized nations the use of malt beverages is at present generally prevalent. Looking down the long vista of the past we can hardly find a period in the existence of man when beer in some form was not drunk by the nations of the earth making claim to most enlightenment. The ancient Egyptians regaled themselves with a brew made from barley, which, although the flavoring quality of hops was not known at that time, seemed to possess so many praiseworthy qualities that it gradually worked its way into farthest Europe. Eventually Germany became the stronghold of beer, and under the scepter of King Gambrinus it is now justly recognized as the national beverage of the German people. From that country and England the art of brewing was transplanted to America, and its product has found such favor with the people of the United States that we now rank as the third largest beer-producing country of the world.

ITS BENEFICENT INFLUENCE.

The beneficent influence and civilizing effects of beer are everywhere apparent. Whatever tends to better man's condition on earth and adds to his physical comfort is worthy of encouragement. This beer certainly does. Being so cheap as to be within the reach of all and having mildly stimulating qualities, it is the superior of whisky and other strong alcoholic drinks in possessing also highly nutritive qualities, which make it essentially the beverage of the laboring and middle classes. But it is also gradually getting to be appreciated for its tonic and strengthening effects, whether in the form of beer, ale, porter, stout, or malt extracts, by the gentler sex throughout the world. That it is slowly but surely crowding that archdemon, whisky, to the wall is amply proven by the official statistics of the last decades, which show that the per capita consumption of whisky is greatly on the decrease while the consumption of beer, which is much healthier and more nutritious, is correspondingly increasing.

As good beer generally contains only from 3 to 5 per cent of alcohol a practical temperance movement has in this manner been inaugurated, which will bear fruit in a great lessening of cases of alcoholism. Thus the brewer of good, wholesome beer becomes as much a benefactor of mankind as he that causeth two blades of grass to grow where but one grew before.

HISTORY OF BREWING.

In ancient times brewing, like the baking of bread, was one of the domestic functions, every family brewing its own beer. The brewing industry, as such, is of a comparatively recent origin. About six hundred years ago it began to develop largely all over the European continent and in Great Britain. About that time the Catholic monks began to establish breweries within their monasteries, and for quite a while they monopolized the brewing business in parts of Germany.

In Vienna, which ranks among the first cities in regard to the quantity as well as the quality of beer produced, the first brewery was erected in 1384. At about the same time Catholic monks built a large brewery at Dobrano, near Pilsen, Bohemia, which brewery is still in operation. During the fifteenth century large breweries were established in Great Britain, where that industry has grown enormously up to the present date.

BREWING INDUSTRY IN AMERICA.

In America brewing dates back almost as far as the introduction of European civilization. The exact date of the beginning of brewing as a distinct calling can not be ascertained, but we know that as early as during the first part of the seventeenth century public breweries were erected, and that the colonial governments encouraged the new industry with all the means in their power.

Van Twiller, governor of the New Netherlands from 1633–1638, built a brewery on the West India Company's farm, which extended north from what is now Wall street to Hudson street, in the present city of New York. In 1638 Roger Williams, of Rhode Island, followed his example, and at about the same time the General Court of Massachusetts Bay passed a law conceding the monopoly of brewing to one Captan Sedgwick. In 1644 Mynheer Jacobus, a Dutch brewer and the first mayor of New Amsterdam, as the present city of New York was then called, established a brewery and a beer garden at what is now about the corner of Pearl street and Old Slip.

It is a fact worthy of note that in the early colonial days the brewing business was entirely in charge of the very best elements of the population. The brewers of those times were mostly men who held high public offices and were greatly respected in their communities.

Among the first brewers in this country who carried on brewing on

a larger scale, and the most famous of all, was William Penn, the founder of Pennsylvania. Although a Quaker and a very pious man, he strongly favored the moderate use of beer. He established a brewery at Pennsburg, Bucks County, Pa., in the latter part of the seventeenth century. There are many others, too numerous to mention, who in those days held high positions and yet did not deem it beneath them to devote themselves to the brewing of beer, which soon became the favorite beverage of the colonists, thus making the business a very lucrative one. Under these circumstances it was but natural that the colonial authorities finally came to look to beer as a source of revenue for the colonies. From the year 1638 the brewing trade expanded to such an extent that a few years later an excise tax upon its product yielded a considerable revenue. From this time brewing formed the subject of frequent legislation in New Netherland and the New England colonies. The lawmakers not only regulated and taxed the manufacture and sale of beer, but they also prescribed minutely its quality and price, the time when and the circumstances under which it could be sold, the duties of the tapster, and the course of conduct of the drinker.

It was not only for the revenue, however, that governors and other public officers encouraged the extension of the brewing industry, but also for the fact that the use of malt liquor proved to be an important factor in the interest of true temperance. This was especially obvious in Pennsylvania, with its large German population, which, preferring wine and beer to spirituous liquors, had an excellent reputation as to sobriety. This experience led Fitzsimmons, a member of the First Congress, to suggest the idea that the production of malt liquors should be encouraged by national legislation.

But in the second century of the colonies' existence brewing declined very rapidly, even in those localities in which it, in the beginning, flourished under the most favorable auspices. The trade with the West Indies, which brought cheap rum in exchange for lumber and other products; the marvelous development of domestic distilling, furthered by exceptional legislative encouragements; the ever-increasing demands made upon the brewers by the public exchequer—all those and other things conspired to reduce brewing to a pitiable state, even in New York and Pennsylvania. The decline of brewing continued up to the time of the revolution, notwithstanding the fact that the lawmakers then improved every available opportunity to hold out inducements to brewers. Hence, brewing relapsed into the primitive state in which it had been at the beginning of its colonial career.

In 1810 the per-capita consumption of beer amounted to only 4.98 quarts, while the consumption of ardent spirits amounted to 18.08 per capita. There were 129 brewers, producing a total amount of 5,754,737 gallons of beer. Seven-eighths of the total production originated in

but 3 States, viz, Pennsylvania, New York, and Massachusetts, with an aggregate population of 2,469,885 inhabitants. There were in all 10 beer-producing States at that time; but the amounts produced, except in the 3 States named, were inconsiderable.

After the year 1810 the brewing industry developed somewhat more rapidly in Pennsylvania and New York on account of the great influx of immigrants from countries in which beer is drank; while in the other States it either remained stationary or progressed very slowly, constantly struggling against great difficulties and impediments.

Between 1810 and 1850 the number of breweries increased to 431 with a total output of 23,267,730 gallons, of which 18,825,096 alone were produced in the States of Pennsylvania and New York, leaving a total production for all the other States combined of 4,442,634 gallons.

Up to about 1842 the greater portion of the malt liquors produced in this country consisted of ale and porter. It was not until then that lager beer was introduced as a product of American industry. In 1842 a German named Wagner, shortly after his arrival in America, established a lager beer brewery in a small building situated in the suburbs of Philadelphia. Two years later another German, Friedrich Lauer, of Reading, Pa., commenced to brew lager beer. He is practically regarded as the originator of the modern American brewing trade.

It was not until after 1850, however, that lager beer began to gain popular favor in this country. At that time German immigration assumed unprecedented proportions, owing to political convulsions in the old country. No wonder that under these circumstances there was a rapid growth of the brewing industry. While the population of the United States increased only from 25,191,876 in 1850 to 31,445,321 in 1860, the number of breweries increased from 451 to 1,269, and the value of malt liquors produced, from $5,728,568 in 1850 to $21,310,933 in 1860.

The only impediment that prevented a more rapid growth of the brewing industry was the cheapness of whisky. Thus far American whisky was not only protected by high custom duties, but also free from any internal-revenue taxes, thus enabling distillers to sell their products very cheaply. The brewing trade, on the other hand, was heavily taxed. The war of secession brought the desired relief. The necessity of extraordinary means to increase the revenues of the Government led to the levying a tax on whisky, thus making it a less formidable competitor of malt liquors.

After the war all industries of this country began to flourish, and the brewing industry was not the last to profit by the new state of things. In the year 1870 the annual production of malt liquors increased to 6,081,521 barrels; in 1880 the production amounted to 10,270,353 barrels; in 1890 the production amounted to 27,561,944 barrels, and there can hardly be any doubt but that at the end of the

present decade an annual production of over 50,000,000 barrels will be reached.

The following table, compiled from the United States Census reports, gives some interesting facts in this connection. From it we find that the quantity of malt liquors manufactured increased 69 per cent in this country from 1870 to 1880, while from 1880 to 1890 it shows the enormous increase of 168 per cent. The quantity in barrels is derived from internal-revenue reports, and is, therefore, quite reliable. A great concentration of the brewing industry is indicated by the reduction in the number of establishments and the immense increase in the capital invested. This apparently disproportionate increase in capital may, however, be somewhat accounted for by the fact that the last census inquiry into this matter was much more searching than heretofore. It will be seen that the seven States of New York, Pennsylvania, Missouri, Ohio, Wisconsin, Illinois, and New Jersey manufactured 78 per cent of the total production of malt liquors in the United States.

Malt liquors.

[From United States Census reports. By totals for the United States.]

Year.	Number of establishments reported.	Capital.	Cost of materials.	Number of employees.	Wages paid.	Number of barrels (not exceeding 31 galls.) produced.	Total value of products.
1870	1,972	$48,779,435	$28,177,684	12,443	$6,758,602	6,081,521	$55,706,643
1880	2,191	91,208,224	56,836,500	26,220	12,198,053	10,270,353	101,058,385
1890	1,248	232,471,290	64,003,347	34,800	28,382,544	27,561,944	182,731,622
BY TOTALS FOR 7 LEADING STATES IN THE INDUSTRY.							
New York:							
1870	281	$12,425,322	$9,194,243	2,942	$2,067,908	1,992,959	$15,818,863
1880	325	27,580,502	19,823,853	8,093	3,912,798	4,599,099	35,392,677
1890	232	67,759,552	18,776,129	8,285	8,035,187	8,572,223	53,429,685
Pennsylvania:							
1870	246	6,966,236	3,553,986	1,583	773,267	788,034	7,056,400
1880	291	12,073,068	5,765,837	2,452	1,200,289	1,343,207	10,124,348
1890	163	26,106,365	6,461,082	3,562	2,831,943	2,762,352	18,358,734
Missouri:							
1870	87	4,631,050	2,377,028	788	597,973	249,112	6,519,548
1880	64	4,942,700	2,852,236	1,502	699,616	756,527	5,048,077
1890	30	16,689,575	6,563,536	3,117	2,441,615	1,883,614	16,954,137
Ohio:							
1870	199	5,337,272	2,711,270	1,305	748,540	570,922	5,753,666
1880	163	8,178,545	5,110,587	2,706	1,184,825	1,245,158	9,125,014
1890	106	21,491,924	5,272,894	3,494	2,828,501	2,393,124	15,899,629
Wisconsin:							
1870	176	2,108,150	935,046	835	258,808	189,664	1,790,273
1880	203	7,253,205	3,536,438	1,680	823,124	853,806	6,312,173
1890	107	16,803,323	4,829,390	3,165	1,864,579	2,067,961	14,193,057
Illinois:							
1870	148	4,884,900	2,023,366	997	481,026	432,278	4,154,224
1880	111	6,098,835	3,261,272	1,648	754,510	805,605	5,798,109
1890	88	21,294,107	4,627,634	2,943	2,056,829	2,281,249	13,664,046
New Jersey:							
1870	46	2,942,300	1,659,113	528	329,139	432,089	3,219,484
1880	49	3,260,800	2,564,748	1,121	493,741	641,344	4,532,733
1890	34	10,184,510	3,592,491	1,395	1,408,932	1,526,590	10,018,393

There are now in this country several brewing establishments each of which produces over a million barrels a year. That is more than the

production of the whole country in the year 1850 amounted to. The growth of the brewing industry in the United States during the last forty-three years can not be more clearly demonstrated than by this comparison.

This country is now the third in rank among all beer-producing countries in regard to the quantity produced. It also has the largest lager beer brewing establishments in the world, far outstripping the famous breweries of Germany and Austria.

As already stated, the large German immigration after the Revolution of 1848 gave a strong impetus to the brewing trade. The Germans who came to this country to seek a living were mostly beer drinkers, and the demand for that mild beverage soon became so great that the speedy erection of additional breweries proved to be a manifest want. With this increased demand it became a necessity to introduce more scientific methods into the brewing business. To-day we can justly speak of the "art of brewing." Some of the most famous scientists, especially chemists, have lent their services to the brewing industry, in order to enable the brewers to eliminate from their product everything that may prove injurious to health. Among the apparatus in a modern brewery we find some of the most ingeniously devised machines and appliances. A modern brewer who wants to keep pace with the progress of his trade must have a considerably better education than the brewer of twenty-five years ago. The primitive methods of brewing that had been employed until within a quarter of a century have been done away with. A brewer who wants to make his product according to the refined taste of the public must have not only a thorough theoretical but also a practical knowledge of brewing from its very start and during all its stages as well as of the method of keeping the finished product.

This demand has led to the establishment of "brewers' academies," where young men are thoroughly fitted out for all the responsible positions in breweries. No doubt the scientific progress of the brewing industry in this country is largely due to these excellent institutions.

ICE MACHINES AND REFRIGERATING PLANTS.

The progress and push of the last half of the nineteenth century, so conspicuous in other branches of industry, has also infused itself into the art of brewing and preserving beer. An exhaustive description of all the machinery and appliances used in a modern brewery can not be given here. One invention, however, deserves to be especially mentioned, as without it the brewing industry could never have experienced such a rapid growth as it has during the last two decades. It is the invention of ice and refrigerating machines. The first experiments in this line were made in 1872, but it was only after a number of years that they were so perfected that they could be used profitably.

Up to that time brewing had been practically confined to the winter season, and the building of immense underground vaults, sometimes quarried out of the solid rock, wherein to keep the beer at a proper temperature, formed a considerable item of the first cost of a brewery. For this reason, too, the establishment of breweries in southern climates, where ice could not be readily obtained, was out of the question. With the introduction of the ice and cold-air machines all this has been revolutionized; every modern brewery is now enabled to keep on brewing all the year round, and even in tropical countries beer is now made which is not to be despised. At the Columbian Exposition, besides beers from such southern countries as Italy, Japan, Australia, and Mexico, there were some fifty samples on exhibition from South America, some of which gave evidence of merit, but, unfortunately, owing to the lack of attention on the part of the representatives of the exhibitors, they had not been kept at a proper temperature and were in no condition to be judged. The samples were chiefly in bottles and had been placed on display in the agricultural building in an upright position, subject to all the changes of temperature, up to the end of October.

THE PROCESS OF MALTING AND BREWING.

Although the general process of making beer is pretty much the same all over the world, yet there is a vital difference in the method of mashing as practiced in England and America and that of Germany, France, and Austria. Here and in England the infusion method is generally in vogue, while in the other countries mentioned resort is had to what is called the decoction method. With us beer is an infusion of malt boiled with hops, fermented by yeast, and then stored until it is ripe for consumption. One not having seen a brewery and not having kept a watchful eye on the many operations used to produce malt and finally beer may imagine that the making of beer is quite an easy task. But it is not.

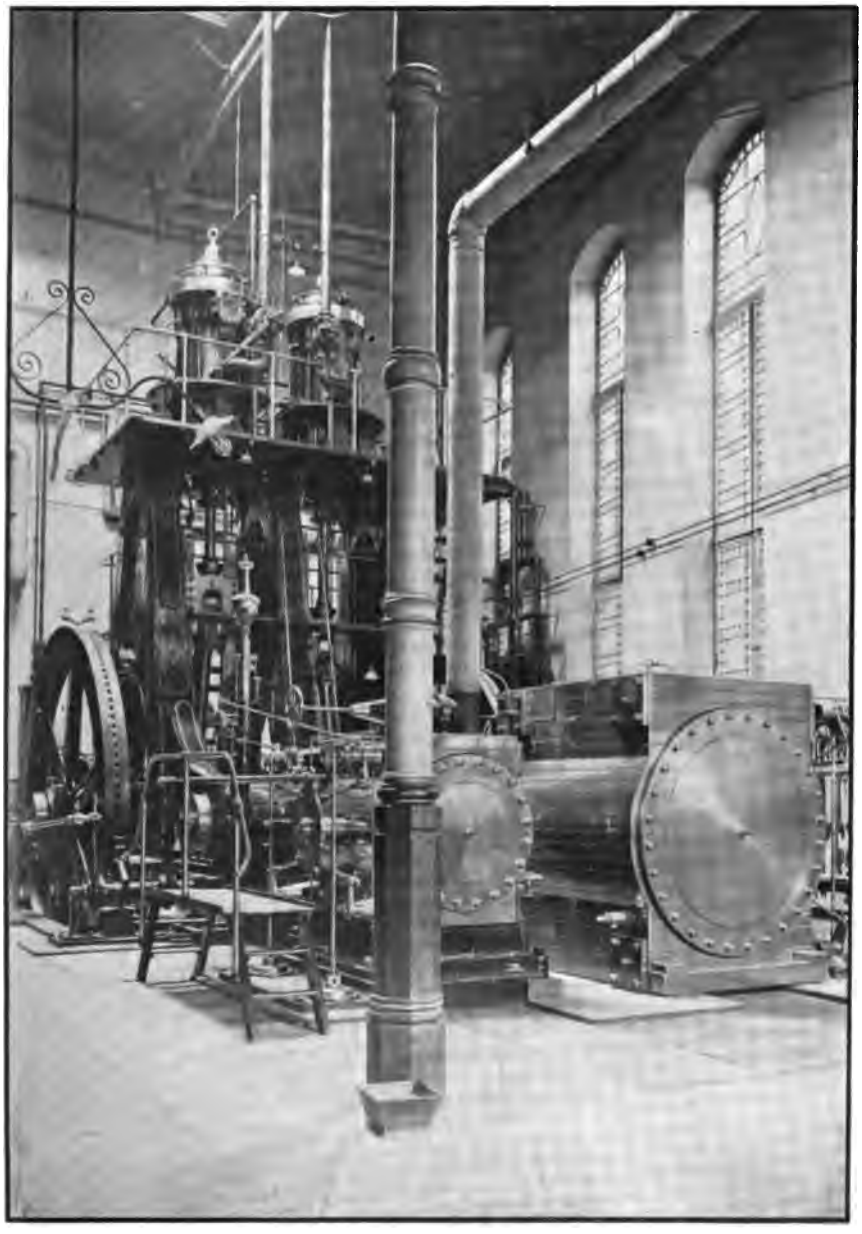
The most important material for the production of beer has always been malt, especially barley malt. It is impossible to make beer directly out of barley, and the same has to be subjected to a process known as malting, which process consists of three operations: First, keeping the barley in water for about seventy-two hours (steeping process), then spreading the barley on floors in couches, while the barley kernels are allowed to germinate, which process requires from five to seven days (germinating process); then drying the malt and removing the germs (kiln-drying process.) The quality of the beer, of course, depends largely on the quality of the malt. In former years most every brewer conducted also a malt house, where he prepared the amount of malt necessary for use in his brewery. Nowadays only few brewers make their own malt, but buy it from manufacturers of malt,

of which there are quite a number in the United States, among them some who produce more than 1,000,000 bushels per annum.

To make beer out of malt it is necessary to mix the malt with water of a certain degree of heat. This process is called the mashing process, and has for its purpose the changing of about 70 per cent of the insolubie substances of the malt into soluble ones. The soluble substances thus produced consist mainly of malt sugar, which is fermented during the subsequent operation. In order to conduct the mashing process well it is necessary that every particle of malt be thoroughly mixed with water, and before the malt is thus mashed it has to be crushed.

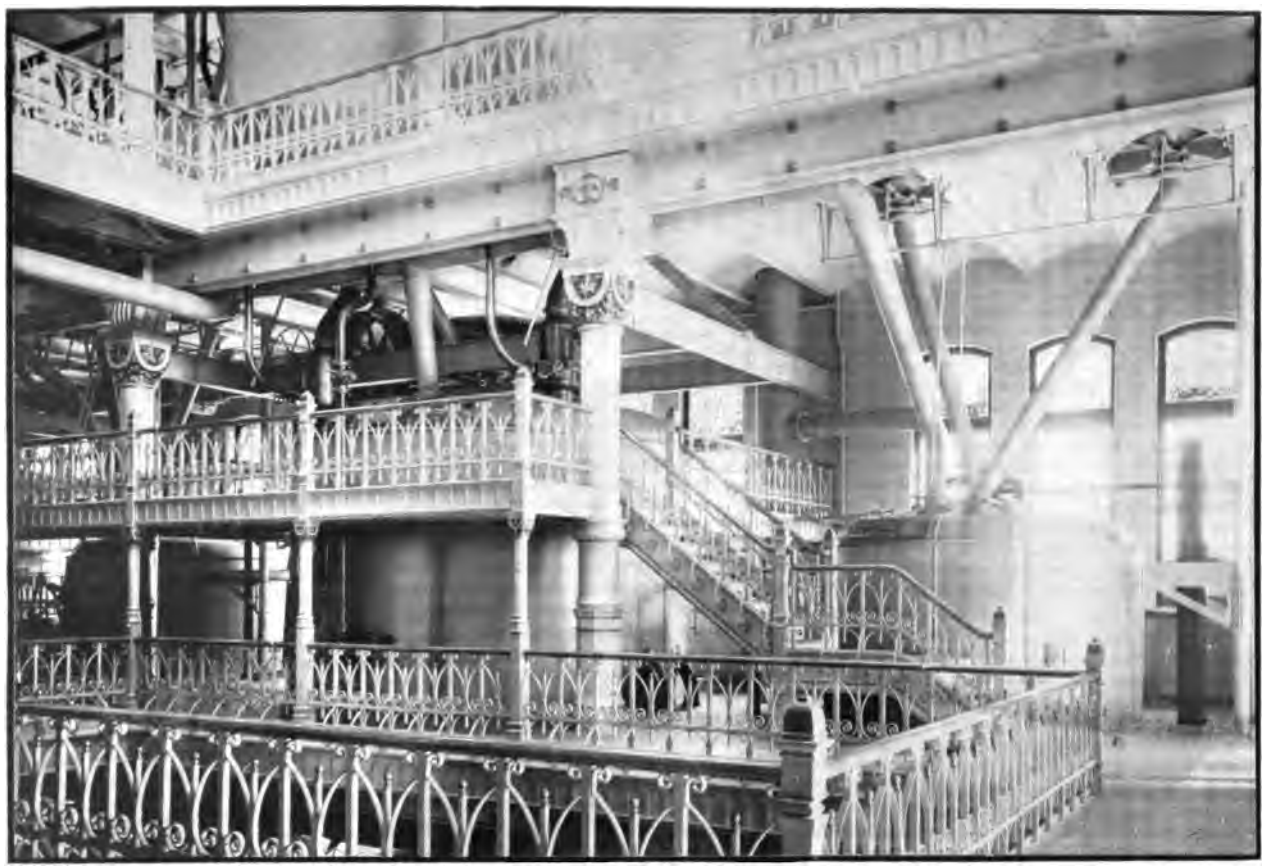
When the brewing of beer was but an infant industry, and the demand for this beverage only limited, the mashing was done in small wooden vessels with the aid of paddles, the motive power being the hands. The capacity of such wooden tubs was naturally not large. Now the mashing is done in large tanks having a capacity of from three to four hundred barrels and the motive power is steam.

After the infusion is completed, the water having dissolved all the desirable substances, the solution called wort is drawn from the insoluble matter, called grains, and the wort is put into another tank, where it is boiled and hops are added. The method formerly used for boiling this wort consisted mostly of heating the same in copper vessels by coal fire, but few of these old appliances are found nowadays. All the modern breweries use copper kettles in which the wort is heated by steam. After the beer wort has been boiled sufficiently it must be reduced to a certain degree of temperature before it is put into the fermenting tubs. Formerly this cooling was done by leaving the beer wort in shallow wooden vessels for many hours. At the present time the wort is cooled as rapidly as possible by having the same run over the coils of a cooling apparatus in which cold water and other refrigerating means are used to shorten the time for cooling. In the old breweries but small tubs were used wherein the beer wort was kept during the stages of fermentation. The process of fermentation is a decomposition of the malt sugar caused by yeast which is added to the beer wort. Practical experience has shown that the fermentation must be conducted at a certain temperature not exceeding a maximum of about 50° F. The brewer was compelled to employ every means to keep the fermenting wort or beer in places where the temperature did not rise above a certain limit. Generally, underground cellars had to be made for this purpose. It was expensive to build such cellers, and in summer it was often impossible to keep the temperature down to the desired degree even when utmost care had been taken in constructing and insulating them. Plenty of ice had to be used, and in spite of every precaution the success looked for was quite frequently not achieved, simply on account of the brewer's



NO. 1.—DELAVERGNE ICE MACHINE. (CAPACITY, 500 TONS DAILY.)

Mau



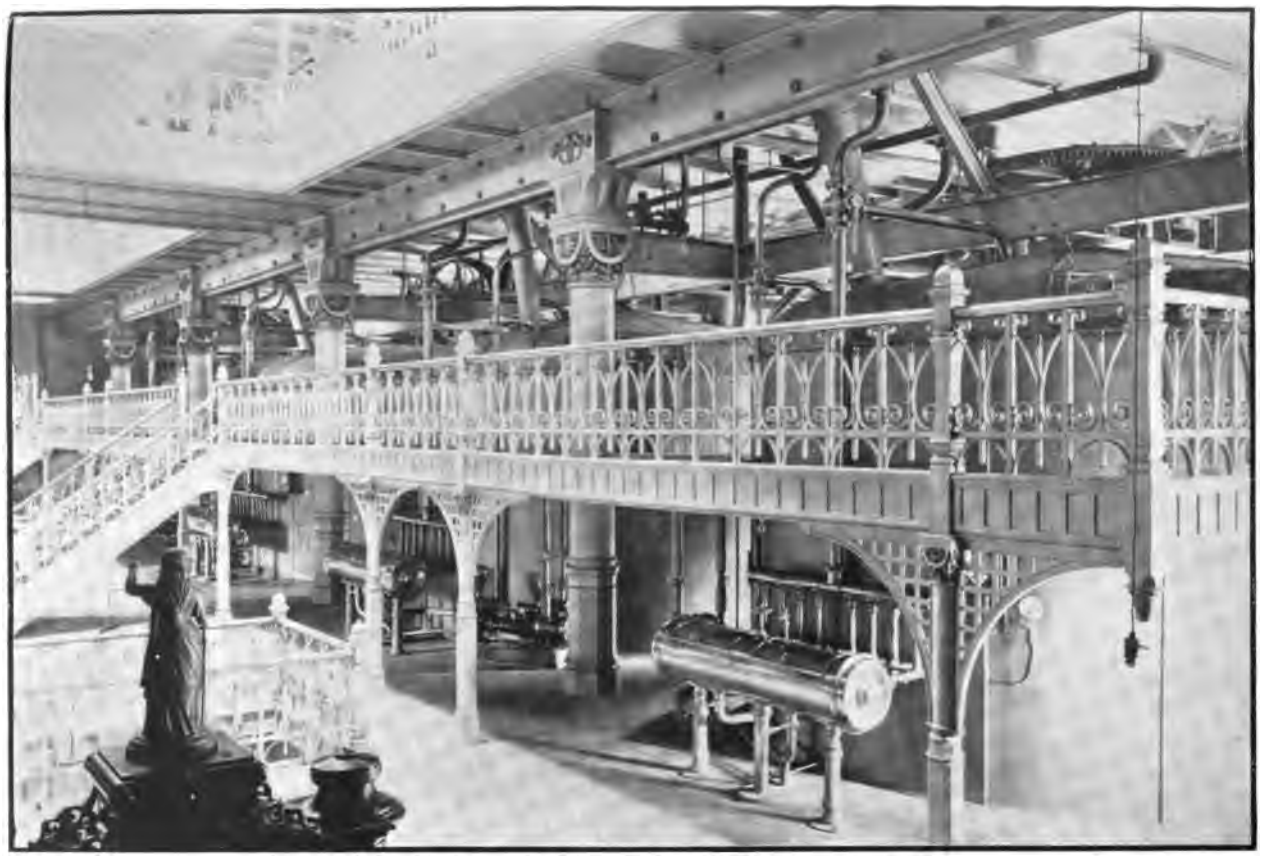
NO. 2.—MASH TUN AND MASH COPPER.

U of M

Scanned with CamScanner

NO. 3.—WORT COPPERS.

U of M



NO. 4.—CLEAR WORT TUNS.

U of M

inability to keep his cellars cold enough. The same misfortune was experienced with those cellars where the beer had to be stored and finished for the market. It is no wonder, then, that in former times the brewers often despaired, because notwithstanding their most diligent efforts and the choice of the best materials, the resulting beers were of poor quality, it having been impossible to control the temperature. In our time it is quite different. After having successfully demonstrated that beer could be fermented and stored in ice and cold-storage houses above the surface by keeping the temperature within a desired limit by means of ice and circulating cold air, the next and most important improvment was made by the invention and erection of cold-air machines which are run day and night in the breweries and keep all the ice-houses and vaults at a very low temperature. This last improvement has enabled brewers to put on the market beers of unsurpassed quality, because it affords the means of exercising rigid control. The fermentation can now be controlled, and even when taking place in tubs twenty times as large as those which were used formerly, everything is regulated with an accuracy that is astonishing.

The continuous growth of the brewing industry, especially the lager-beer brewing in this country, naturally gave an impulse to many inventors as improvers as far as mechanical appliances are concerned, steam and electricity supplying the mechanical means which formerly were not thought of. Hand mashing has been superseded by powerful mixing apparatuses, driven by steam or electricity. Every mechanical operation is carried on by other than manual labor, if possible. This is also the case in the preparation of malt, where hand work is more and more dispensed with.

Besides barley, other cereals are frequently used in the manufacture of beer, such as rice, corn, rye, etc., chiefly on account of their greater cheapness. In this country especially the use of Indian corn, or maize, is now becoming quite prevalent, but the old-time beer drinker will be slow to put the seal of approval on any beer not made out of hops and barley malt.

BOTTLING BEER FOR EXPORT.

Science has greatly enhanced the development of beer brewing by demonstrating that all operations used in brewing are subject to natural laws and many improvements are due to scientific researches. One of the greatest achievements in this regard were the results obtained by a careful study of those conditions and circumstances which prevent the spoiling of beer. Science has in this matter given practical advice how to treat beer of which long-keeping qualities are expected. The result was that the brewer has been enabled to bottle his beer, and after a process of sterilization send it to all parts of the globe where such products were not previously known. In order to give the beer a more

stable character it is usually treated by Pasteur's method of sterilizing the germs. These germs are fatal to the stability and brilliancy of beer and it is therefore necessary to get rid of or devitalize them. They may be to a large extent suppressed by giving the beer a greater percentage of alcohol, but this is not desirable. Almost generally the process of pasteurization is now employed, under which the bottles already filled with beer and having been carefully corked and wired are stood upright in water, the temperature of which is gradually raised to about 140° F., and so kept for some forty minutes. By this process the germs are so entirely destroyed that their reappearance is impossible.

The beer-bottling industry has attained its greatest development in the United States, from which country bottled beer is now shipped to all parts of the world. The American bottled beer is especially renowned for its brilliancy, pleasant taste, and long-keeping qualities.

In conclusion we should bear in mind that the phenomenal development of the brewing industry has also given a strong impetus to the culture of hops and raising of barley, thus coming to the aid of the agriculturist. It has, besides, caused large glass factories for the manufacture of bottles and glasses to spring up in various parts of our country, and has in many other ways expanded the employment of labor.

WHISKIES, ETC.

By Guido Marx.

Many difficulties combine to prevent giving to the extensive collection of exhibits such proper justice as its importance would demand, and I am induced to make the attempt only by the conviction that whatever might be dictated by a sufficient understanding of the subject would be of general interest. Furthermore such information would tend to a better comprehension of a group of products which is of such high economic value to all countries, and which in addition supplies the Federal as well as the local governments of the United States not less than most foreign Governments with financial resources amounting to thousands of millions of dollars every year.

Practical business acquaintance extending over an ordinary lifetime, repeated and extensive traveling on both sides of the Atlantic, and official connections with former expositions enable me, perhaps, to give the subject that treatment and attention to which it is entitled in view of the fact that every nation represented at the World's Fair had sent some exhibits in this line. And it may well be said that most of them were more proud of their contributions to this particular branch of it than of any of their other productions.

One of the principal difficulties in giving a comprehensive review of this part of the Exposition consists in the fact that owing to its extent I was only one of ten gentlemen intrusted with the examinations in this particular group, and that differences in personal taste had to be accepted largely in the determinations of merits. Another reason making it almost impossible to give a more complete review of the attainments in the science of distilling consisted in the classification of the Exposition separating agriculture and its produce from those of horticulture, assigning to this the products of distillation from grapes and other fruits, which consequently were contained mostly in a separate building and submitted to a totally different set of judges. This arrangement took from the consideration of our board the entire subject of brandies and left it very much like the well-known play of Hamlet with the title rôle omitted. Still there were plenty of exhibits within the confines of the assignments to occupy our attention and exercise our palates for several weeks during the hottest part of the season.

Group 11, Department of Agriculture, according to the classification adopted, consisted of the following classes: Class 66, high wines—whisky and its manufacture; class 67, rum and other distilled spirits, as saki, samshoo, etc.; class 68, alcohol, pure spirits; class 69, cordials and liquors; class 70, bitters and mixed alcoholic beverages; class 71, cider and vinegar.

To give an idea of the extent of the Columbian Exposition in comparison with the Centennial in Philadelphia in 1876, of which I had also the honor of being one of the judges, I might mention that while in the latter all spirituous liquors, including wine, beer, cider, and vinegar, formed but one group and were all examined by one body of judges and reported on in general by me, the World's Fair gave enough to do to keep at least three sets of judges in hot water more than in good spirits for considerable time.

To the fuller consideration and examination of the articles comprised in this group, the following gentlemen, who had been appointed as judges in agriculture, were specially assigned: Count Adelmann, of Sigmaringen, Germany; Mr. Bannister, London, England; Rudolph Beyfuss, Vienna, Austria; J. Stoddard Johnson, Kentucky; Dr. Lichtenfeld, Berlin, Germany; Guido Marx, Toledo, Ohio; C. A. Preston, Haiti; A. A. Rehbinder, Russia; Tawara, Japan; Wilkens, Netherlands.

At the first meeting of the judges of the group on August 21, Guido Marx, of Toledo, the writer of this, was elected president, and Mr. Rudolf Beyfuss, of Vienna, secretary. After Mr. Beyfuss had discharged his share of the work, Mr. A. A. Rehbinder, of Russia, was appointed in his stead, and following him Mr. J. Stoddard Johnson, of Kentucky. For the guidance of the judges a set of rules were adopted, with the approval of the executive committee on awards.

To insure as near an approach to conformity on the points of merit required in judging the several exhibits the following scales were adopted and blanks furnished for the record of the scores. The standard of excellency was to be 100 points; these were to be distributed as follows: For alcohol and pure spirits, whiskies, brandies, etc.: For chemical purity, 25; for perfect distillation, 25; for aroma, bouquet flavor and taste, 25; for general characteristics or appearance and condition, 25. In liquors, cordials, bitters, vinegar, and cider the 25 points counted for chemical purity were to be allowed for absence of alien matter.

CHEMICAL REPORT FOR PURITY.

In order to insure the highest reliability to the examination of the chemical constituents of the alcoholic beverages, Prof. H. W. Wiley, the expert chemist of the Department of Agriculture, was requested by the executive committee on awards to make the chemical analysis

of such samples as would be submitted to his test by the judges. His report as far as pertinent will be inserted below. It was resolved that no exhibit showing less than a total of 90 points of merit should be reported for an award. In American rye whiskies, to insure the highest value to the awards to be granted, this standard of excellency was advanced to 95 points, although this resolution was modified in its application later on by the executive bureau. Referring to such cases where an individual or firm exhibited a variety of articles and where several might be deemed worthy of award, it was resolved that but one award should be granted and said award should cover the collective exhibit. For reasons unknown to the writer this rule was, after his departure, not strictly adhered to. The original official classification having been such a peculiar one and many of the exhibits being of such a character which made their consideration under any of these specific heads rather impracticable the writer of this prefers in the following to adopt such a subdivision as commercial usage has established.

In accordance with this, alcohol takes the lead, being the principal ingredient of all liquors deriving their character from its substance, no matter whether same is present in its pure condition, in greater or less proportion, or whether it appears under various admixtures. Be it used either as pure alcohol for the purposes of science, for application in arts and manufactures or in its reductions as a beverage, the question of quality is the principal one. Alcohol can be produced from any substance containing sugar or saccharine matter, and whichever plant yields the most of this and relatively at the least cost will be the one to furnish the chief supply in any country. With its application upon the health of the consumer when used as a beverage, or its effect from a medicinal point of view, we have here nothing to do. This is a question upon which, as proverbially expressed, doctors disagree and probably will differ as long as there is a drop of it left. All we have to report upon is the quality and condition of that which is offered to the public for consumption.

In the United States the main source from which alcohol is derived is through the distillation of maize or Indian corn. By a combination of circumstances and a large amount of capital its principal production is at present practically in the hands of one company, the so-called trust. It is very much to be regretted that the management of this extensive corporation, including all the principal distilleries of alcohol and pure spirits in the country, did not show public spirit enough to have their industry similarly represented as that other well-known corporation, the Standard Oil Company, did in giving such an excellent exhibit, embodying their modes of refining petroleum.

The distillation of alcohol has made considerable progress in every civilized country. The description of the processes and the apparatus

by which it is carried on would fill a volume for itself. One patented process for purifying liquors or spirits coming from Massachusetts was granted an award.

Of the enormous quantities distilled in the United States only one sample was exhibited, but this was interesting enough by having been produced from the root of the cassava plant, raised in Florida. The alcohol was of excellent quality in every respect. Other American countries—Brazil, the Argentine Republic, Cuba, Guatemala, Venezuela, and Uruguay—were numerically much better represented than our own, the good appearance and perfect neutrality of their alcohol showing considerable advance in the science of distilling high-proof spirits. Of all European countries, Russia and Spain alone showed up in the alcohol column. The material of the former was undoubtedly rye, and the latter spirits of wine or sugar cane, although not stated so specifically.

PURE SPIRITS.

What has been said regarding the lack of exhibits in the line of alcohol must be repeated in connection with pure or neutral spirits, the production of which in the United States is of considerable magnitude. Its exhibition was entirely neglected. The best representation we had in this line came from Russia. We had occasion to report for awards the names of eleven firms in all parts of the Empire for the excellent quality of the "Vodka," the Russian name for what are called pure or neutral spirits in America. In this country their manufacture is mostly carried on in the same distilleries where alcohol is produced, by redistillation of the high wines, and by reduction with distilled water to the required strength.

WHISKY.

This is the principal distilled beverage of the people in the United States. It is subdivided according to the material which constitutes its main ingredients. These are maize or Indian corn, rye, barley, and wheat. In most cases several of these ingredients are used together in varying proportions to produce such changes in quality, price and aroma as are demanded by the trade. The cheapest of all our whiskies are produced by the reduction and rectification or redistillation of alcohol or spirits. These have been substituted for the high wines formerly used for that purpose, because they can be obtained from the distilleries at almost the same figures and of such purity generally that they require little additional rectification. It can be asserted also with full confidence, and by personal acquaintance with most of the goods offered to the trade, that no adulteration is practiced by any responsible concern. The simple substitution of the names of the materials or grains used in distilling or compounding can hardly be called such where several are mixed indiscriminately. This is also the

reason why as far as chemical purity is concerned, the cheaper grades of whisky in the United States are as wholesome as the more expensive. The component of most grains, seeds, and potato called fusel oil, which gives many alcoholic beverages that disagreeable rasping taste, has been eliminated in these by rectification and redistillation to a greater degree, yes, even entirely, while the presence of some of it has to be relied upon for the formation of flavor or aroma in straight whiskies. As far as the present state of science affirms, the volatile oils furnishing the aroma, boquet, or flavor of higher grade whiskies are produced by a saponification or oxidation of the fusel oil under the influence of time and heat. From this follows also that the so-called straight whiskies, being those that have not been rectified or redistilled, are not as pure in this respect, and not as fit for consumption as those usually called compounded or blended. Straight goods, unless they have been carefully distilled and have been kept a sufficient length of time under proper condition, are in no way preferable to conscientiously compounded blends.

The straight whiskies, as to their quality, rely for the development of aroma, in the first place, upon the careful selection and composition of their material and its distillation and redistillation, and then upon sufficient time and atmospheric influence to mature the qualities which distinguish them from the other grades. To hasten this maturing, the warehouses in which the whiskies are placed are often heated artificially. It is of great importance to the jobbing trade that the uniformity, quality, and proper bouquet can be relied upon to develop from new whisky, because large quantities are sold and paid for from two to five years before they are withdrawn for actual use. The other grades depend for their chief characteristics and preference upon a well-distilled and carefully rectified spirit as a basis, to be flavored and compounded, according to the requirements and tastes of the customers, with such material as will suit them the best, generally with sufficient old and highly flavored whisky to give the proper taste. These goods can, therefore, be sold at much cheaper rates and still be just as pure, and sometimes more so, than the former, which require considerable outlay of capital and occasion much loss by evaporation, interest on investment, and expense of storage for longer periods.

The question as to relative merits of straight and compounded or blended liquors is much better understood in Great Britain, where the Government has but lately instituted a commission to report on the subject according to its importance. In the United States blending has not been countenanced, for the mistaken reason that it has been considered of greater value to the Government to be able to identify spirits in all its passages from the still to the tumbler of the consumer in order to detect any peculation by its own officers in collecting the revenue on the spirits.

Before the war of secession the questions of proof were seldom raised and liquors of less than proof strength were considerably sold over the bar. Since then, however, governmental regulations have necessitated marking and branding the packages, and consequently liquors of full and higher proof had to be and were supplied. The direct result of which was that the consumers became used to drinking much stronger liquor, thereby causing more intoxication, because the dealers had not the privilege nor facilities of suiting its strength to their own and the customers' advantage. It took some expensive litigation before the internal-revenue authorities would allow even the admixture of saccharine matter, which is in many cases of decided benefit. This resistance to compounding favored in many ways the use of the two-stamped goods—that is, those that came directly from the Government warehouses to the retailer. It was pretended that such goods were purer and more palatable than those which had passed through the hands of the rectifier or compounder. This erroneous view was largely fostered by the competition of a number of small distilleries, especially in Kentucky, and of many larger ones who made greater quantities of whisky than could be placed by the jobbing houses, and who, consequently, sought the retail trade to assist in disposing of their holdings. The impossibility of selling these before the time came when the taxes thereon would have to be paid caused a continuous demand for the extension of the bonded period far beyond what, under proper conditions, would have been required.

The period at which a well-distilled sour-mash whisky reaches its maturity is from five to six years. If it is not ripe and fully developed by that time, no amount of further storing will make it any better. The sweet-mash whiskies reach that condition of perfection even in less time, two to three years being sufficient to develop their best qualities. Notwithstanding this, large quantities of these whiskies are withdrawn annually before maturity by those anxious to realize on their investments as soon as they can find a market for them. In addition to this, certain quantities are made on what are claimed as quick processes, but which are in reality mostly only spirits made suitable for immediate consumption or for use within one year.

But of all aging processes we have found none more reliable than time, assisted by a warm temperature. Various other modes have been introduced, some to apply electricity, others to keep the packages in motion, but none of these were exhibited nor appear to be successful. The only way practiced by leading houses to give new whiskies the flavor and taste of older is by the addition of a sufficient quantity of the latter to gain the desired end—that is, by judicious blending.

In order to overcome the fiery taste of new liquors an addition of sweet wines, fruit sirup, or other plain sirups is practiced, which answer fully the purpose and are entirely innocuous. The use of glycerin and glucose has not found much application. More con-

sumed for this purpose is an article called prune juice, which has formerly all been imported but is now also prepared in this country. We had a sample of it submitted and found it worthy of an award. Inasmuch as for the prices usually obtained high grade old whiskies can not be supplied, and as it is admitted that the essential object sought is a well-distilled base with a good flavor, there can be no objection to proper compounding or blending. In many ways it obviates a loss which is incurred by holding all whiskies a full length of time. The loss by evaporation is not less than 10 per cent per year, which would amount to from 40 to 50 per cent in five years. (The allowance is 7½ gallons per barrel for three years under the Carlisle bill.) The interest on the investment amounts to at least 6 per cent per year more, to which the charges for storage and insurance have to be added, all of which can be saved by a preference of properly blended over straight goods, which latter are too often not sufficiently matured. Besides, there are other reasons more fully alluded to in the letter given below. These views of the judges were fully sustained by the examination of the blended whiskies exhibited by some of the leading houses, which were awarded their just share of premiums, in comparison with the samples of straight goods exhibited by the most prominent distilleries.

In connection with this part of the subject I desire to introduce a letter by Mr. August Wolpert, a gentleman of long experience in handling whiskies, in the sale thereof, as well as in compounding and selling. He writes:

Mr. GUIDO MARX,

Judge of Awards, Columbian Exposition.

SIR: From the preliminary report of the judges of the World's Columbian Exposition, I am glad to see that justice has been done and indorsement given to a very important article of manufacture and commerce in our domestic whiskies, viz, to the so-called blended goods; that is, whiskies compounded by responsible and reliable dealers from good old brands, whether rye, corn, or malt. The judges have concluded that a carefully blended or compounded whisky, which according to law requires but one stamp on the package into which it is placed, is fully as good or better than many of the so-called two or double-stamped goods. A good blend can not be made from poor whiskies. The distiller knows only too well that if his whiskies are given say five or six years' age, the proof of the same will increase to such an extent that if the whisky gets into the hands of the retailer and by him is set out to his customers over the bar, he, the customer, would pronounce the same fiery, hot, rank, and new, simply because the whisky during the five or six years of aging has gained 5 to 12 per cent in proof of strength. So a whisky, after being distilled and then weighed by the United States gauger, showing 101 per cent proof would, after the expiration of five or six years, weigh from 106 to 112 per cent, according to the temperature of the warehouse in which the same was kept. Whisky at 104, or still more at 110, is too strong altogether to be put into the stomach of a human being. Its effects can not help but be terrible, no matter how good and pure the whisky may be otherwise. One stamp or blended whiskies will easily overcome this, for the simple reason that most all reputable and first-class wholesale liquor dealers have ready for use pure distilled water with which they reduce their high-proof whiskies to such a

strength as to make the same taste pleasant and smooth. This can be properly done only by the wholesaler, firstly, because the retailer is legally not allowed to reduce his whisky in the original package, and, secondly, because most of them are never in possession of distilled water, which is the only water to be used in reducing high-proof goods, and they would therefore make a failure by using hard and ordinary water for that purpose. Hard water or any other water except distilled water will never mix well with whisky. It always leaves the whisky cloudy and never gives it that brilliancy which distilled water does. Many compounders also use in addition to distilled water pure rock candy sirup, and also some fine fruit juices. The latter, especially when pure, will only add to make the whisky taste more palatable and smooth, and when compounded with some good old whisky will only help to improve the taste. This compounding should be done in large quantities only and not three or four gallons at the time. Whiskies after being compounded in barrels are generally given another six months' aging, so as to give the different ingredients a chance to fully unite with each other, after which the whisky will be ready for use.

It is just as my correspondent says—blending is a science in itself, and can not be successfully done without sufficient knowledge and the proper means of carrying it on correctly. If good blends are better than raw, straight whiskies, then they can be made so only by use of finest neutral spirits, the best flavored whiskies well matured, and carefully distilled water. They will also be relatively cheaper and more palatable than straight goods, which have been left from two to eight years, occasioning unnecessary loss and outlay for a large part of the product. In the East this practice has been recognized for a longer period, but in the West the delusion is still kept up by interested parties that whiskies bearing two stamps are preferable, no matter what their qualities otherwise might be. With more than ordinary pride the distillers and compounders of the United States can point to the report given herewith of Prof. H. W. Wiley, the Government chemist, of the analysis made of the whiskies and other liquors submitted to his examination. They contained samples taken from the exhibits of all the distilleries represented, and were collected without the knowledge on the part of any of the interested parties that such exact investigations would take place. Its result proved, however, that the straight as well as the blended whiskies sold by the leading houses were perfectly free from any deleterious or alien substance, and pure and fully up to the standard required. This contradicts the oft-repeated rant, asserting and preaching that pure liquors could not be had, and that all were more or less adulterated and drugged. No other department of industry supplying public wants in the line of food and drink, wearing apparel, or for any other purpose can show a better record for purity and genuineness of material in use. The annexed report of Professor Wiley will prove this:

JACKSON PARK,
Chicago, Ill., August 19, 1893.

SIR: I beg to report the following examination of alcohols, whiskies, and brandies. The distinguishing marks are those given me by the judges. In regard to the whiskies and brandies I will say that they were found without deleterious sub-

stances, but in some cases there appears to have been added to them burnt sugar for the purpose of coloring. This is particularly the case with Nos. 19435 and 2238. In regard to the other samples our examination shows that they are pure and fully up to the examination required.

I am, respectfully, H. W. WILEY.

Hon. JOHN BOYD THATCHER,
Administration Building, Jackson Park, City.

Results of the chemical examination of samples of alcoholic liquors for the Bureau of Awards, World's Columbian Exposition.

Bureau of awards No.	Specific gravity.	Temperature, specific gravity taken.	Alcohol.		Dry extract (grams per liter).	Kind of liquor.
			Volume.	Weight.		
			Per cent.	*Per cent.*		
21,155-1			95.5	93.17	0.0	Alcohol.
25,163	0.8025	25.5	96.3	94.41	0.0	Alcohol, N. Vorogonshion.
25,171	.8043	25	95.2	92.74	0.0	Alcohol, Marinsky Distilling Co.
25,173			95.7	93.46	0.0	Alcohol, S. Christiakoff.
21,155-2	.9460	24	41.6	34.30	1.91	Brandy, P. Snainof.
25,160	Bottle broken.		40.6	33.93	1.11	Brandy, Bollman & Co., St. Petersburg.
25,164	Sample insufficient in amount.		43.3	36.34	.62	Brandy, N. Vorogonshion Novosil.
25,172			40	33.39	.42	Brandy, Marinsky Distillery, Lipetsh.
25,174	0.9454	25	41.7	34.90	.70	Brandy, S. Christiakoff.
2235	.9259	24.5	56.4	48.63	1.82	Whisky, J. H. O'Hara.
2238	.9269	24.5	55.6	47.84	6.50	Whisky, Moore & Sinnott.
2645	.9199	23.5	59.1	51.26	1.17	Whisky, A. Guckenheimer & Bro.
2667	.9208	23	51.8	44.20	1.90	Do.
4719	.9275	25	49.6	42.13	1.87	Whisky, Dallemand & Co.
11,735	.9151	24	59.2	51.48	2.05	Whisky, Ulman Goldsborough
11,740	.9297	24	53.6	45.91	2.43	Do.
11,805	.9318	23	48.6	41.19	1.75	Whisky, Hiram Walker & Co.
18091	.8135	25.5	93	89.71	0.0	Cassava alcohol, Disston, Okeechobee Drainage Co.
19,414	.9249	24	54.8	47.06	1.48	Whisky, Large Distilling Co.
19,417	.9257	25	50.4	42.66	1.16	Do.
19420	.9235	24	51.9	45.10	1.60	Whisky, Old Times Distilling Co.
19435	.9296	23.5	59.3	51.68	7.17	Whisky, Bernheim Bros.
25464	.9155	24.5	62.5	54.67	1.65	Whisky, The Hannis Distilling Co.
25470	.9108	25	63	55.18	1.88	Do.

The favorite kinds of whisky in the United States are rye whisky, Bourbon whisky, and malt whisky.

RYE WHISKY.

Rye is generally used in connection with some barley malt to produce the most highly flavored of American whiskies. It requires about five years to gain its full maturity. Some of it is produced in the States of Kentucky and Maryland, but the chief supply comes from Pennsylvania. Nine of the principal distilleries in these States exhibited full lines of their vintages, some of these as old as ten years, proving thereby their uniformity in quality and the improvements gained each year. We had the pleasure of awarding premiums to eight of the firms exhibiting straight and several blended goods in this line. Of foreign countries, Russia and Germany sent some rye whisky in the American style which merited approval.

BOURBON WHISKY

derives its name from Bourbon County, Ky., in which State at present it forms in many counties one of the most important industries. The basis of the whisky is the hard or flint corn or maize peculiar to that State, with such admixture of rye and barley malt, called small grain, as experience has shown to be most advantageous in each case. It is also claimed that the water of the springs from the calcareous formation of the State has something to do with the excellence of its product. Be that as it may, of the large number of flourishing distilleries in that State and in the neighboring one of Tennessee, where also some good "Bourbon" is made, but six showed up with exhibits at the World's Fair. These were not nearly the most extensive ones, but secured what they deserved, viz, four of the prizes. If a sufficient attempt had been made to give the State its proper representation it would have made a far better showing.

MALT WHISKY.

Malt whisky is distilled in the United States only in a very limited quantity, and that is principally used for flavoring and advertising purposes. But one distillery submitted a full line of samples, which, however, was very satisfactory. Our supply of whisky of this kind comes mostly from Great Britain—that is, England, Scotland, and Ireland—and Canada, which introduced enough fine samples to carry off ten awards. Liquors in the style of whisky, and called so probably in honor of our national beverage, but derived from divers materials, most likely the juice of sugar cane, were exhibited by Uruguay and Cuba.

RUM.

Rum, which used to be so popular in the United States that it is said that for every missionary sent out from the city of Boston to civilize Africa 10,000 gallons of it were sent along on the same ship, was entirely neglected as far as its representation at the Columbian Exposition was concerned. We did not meet a single sample of the New England rum which has spread the fame of this section probably farther than any of its Yankee notions. Most every other country on the globe hastened to make up for this lack of patriotism in our own, even to distant New South Wales. Their efforts were recognized by awards for three samples submitted by Mexico, distilled from the juice of sugar cane, one from Costa Rica, four from British Guiana, thirteen from Brazil, and one from Paraguay. The West India Islands maintained their old superiority in the distillation of rum by obtaining eleven awards for Jamaica, four for Haiti, and one for Cuba. The mother country, Spain, secured three, and even Germany one.

BRANDY.

By the exclusion from this group of brandies distilled from grapes and other fruit, by their assignment to viticulture and exhibition in horticultural hall, we were relieved of the examination of the largest part of what are commercially considered some of the foremost of alcoholic liquors.

France having withdrawn from competition all the goods which she exhibited caused a large blank space to be left in any report which might be written about this class—a space which can not be filled or supplanted by any other country, although to our knowledge, from business acquaintance with the subject, some of our own States, especially California and Ohio, have succeeded in producing highly creditable brandies.

The accident of installation left some brandies among the exhibits in agricultural hall, and we assumed proper charge of the waifs belonging to our family. Among these were some especially splendid brandies distilled from cherries and other small fruit from Baden, Germany, which obtained twenty awards. We also found occasion to premiate German cognac and a substitute for same. Italy presented to us several of her "aquavitae uso cognac," which compared well with the best of these.

Mexico introduced the brandies called mezcal, made from the juice of the agave or century plant, and obtained seven awards for the same; also one each for brandies distilled from mesquite or the sweet bean and from "Guaste comate."

Guatemala and Costa Rica received recognition for spirits of uva or grapes; likewise Haiti for such from plums. Among the large exhibit of Brazil were many fine distillations from the fruits peculiar to that country. Habana, in her rich Cuban collections, also included brandies.

GIN.

This liquor, from which preeminently medicinal qualities are claimed, was not as numerously represented as its commercial importance would have suggested. Our largest supply was formerly imported from the Netherlands and England, where a few prominent distillers did not neglect the occasion to keep the American public informed that they are still in existence. Their attention was fitly rewarded. Cuba and some South American States—Uruguay and Costa Rica—showed their acquaintance with the use of juniper oil by presenting Hollandesa and Ginebra of rather indifferent quality. Conspicuously by its entire absence, however, was the American industry in this branch, notwithstanding the fact that it has succeeded, by improvements in the distillation of domestic spirits with juniper berries, in replacing in the

favor of the public much of the imported gin. Consequently we can give no account of an advance where those who should have been in the line of march themselves failed to materialize.

ARRACK.

The interesting exhibit of the Sultanate of Johore, from the Malayan Peninsula, gave us the first opportunity to examine side by side the spirits bearing this name made from rice sweetened, and plain, called nasi at home, and those won from the juice of the date palm, called "khorma." But neither presented itself to our perception as advantageously as the arrack, exhibited by a Rotterdam firm, which was more suitable to Western taste. Its origin was not indicated.

CORDIALS AND LIQUEURS.

Under this head are contained all sweetened liquors, no matter of what alcoholic proof. Those of the greatest strength are frequently designated as ratafias, while such as contain a large proportion of saccharine matter are called cremes. A superabundance of sugar is sometimes added to produce crystallization for ornament. The number and variety of cordials is endless, as every part of innumerable plants and trees, from the root and bark to the leaves, flower, seed, and fruit, is made use of for their composition and flavoring. Some are of standard kinds, and well known the world over, favorites in countries far removed from each other. To these belong anisette and kümmel; the latter, made of caraway seeds, is, according to strength, either plain or double, "doppel;" the Russian name of the latter is allash, the former ekau. Other well known sources of flavor are peppermint, ginger, cloves, cinnamon, vanilla, and the ordinary fruits—grapes, blackberries, raspberries, gooseberries, currants, quinces, plums, apricots, pears, limes, and oranges. The liquor made from the bitter orange named cuiracao is imitated everywhere. Cacao, chocolate, also green and roasted coffee, furnished excellent aromas for other fine applications. Many of these are produced by a redistillation of the ordinary spirits of the country with the substances preferred, others by maceration, and the rest by the so-called cold process—i. e., the infusion of the necessary essential oils into the spirits and sugar. Denmark, Russia, and Italy have attained the greatest perfection in the use of cherries.

Other cordials, the composition of which is kept a trade secret generally, derive their name either from the place or vicinity where they were first made or are principally manufactured or where they are supposed to come from. For instance Chartreuse or Benedictine, about which the French advertisers tell quite interesting stories. A number of these are well known by private brands, such as Neapoli-

tan, San Bernardo, Khedive, Elixir, Piria, "The Aqua" of Grondola, the Elixir Efesina of Taranto, and others. Then we have those kinds which are peculiar to certain countries. Among these we cite the Swedish punches. These are mostly fine spirits of rye, flavored with plenty of East India arrack and sweetened to such a degree that they make a highly palatable drink without further reduction. This is not to be confused with the essence or extract of punch, which is a composition of rum or arrack, and other spirits with lemon and sugar, which, by the addition of hot water, is much consumed in Germany and to which the great poet Schiller has dedicated two handsome, inspiring poems.

Some liquors may be considered as the natural products of certain countries, and inasmuch as fashion is an element in the compounding of beverages as well as in other walks of life, industry is as active in this branch as in any other to avail itself of every fresh opportunity to introduce novelties. In this connection, therefore, it appears interesting to name in the list of cordials such recent additions as have been presented by the various countries. And this is peculiarly appropriate in those cases where the distillers and compounders have availed themselves of their native resources instead of imitating old imported or hackneyed formulas and brands. In this category the United States presented as comparatively new and meritorious only rock and rye, egg cognac, and blackberry cordials. The first named is a composition of rye whisky with rock candy. Egg cognac is an imitation of a French liqueur lately introduced, being a mixture of brandy, the yellow of eggs or some oily substitute, and sugar. It was found quite palatable. The blackberry cordials appeared to answer their purpose, whether prepared according to the Pharmacopœia or not.

Costa Rica treated us to liqueurs called mararone, mistala, and yerbabuena, which latter very much resembles mint.

Guatemala introduced nance, the redistillation of a white, cherry-like fruit, mamey canela, or cinnamon pina (pineapples), palma, cafe, and tecum. The novelty from Colombia was anisette of cocoanut.

Paraguay surprised and puzzled us with tafias of capricato, ananas, quarirami, banana, yerba nate, and moka.

Russia made us acquainted with liqueur from sorbus, or mountain ash, that would hardly "take" with the American taste; with some made of black currants, that might suit better, and sweet cherry brandy, which was hardly inferior to the Italian sugo de'ciliegie nere selvatiche. Pommice, or treber, and plums also furnish good material in the north. From the south the small but celebrated principality of Monaco offered us, among other delicate liqueurs, coffee with calisaya and the specialty of Alpine de Monte Carlo.

The Ottoman Empire renewed our old acquaintance with its superb sage, mint, and Melissa liqueurs.

From the antipodes, in New South Wales, we received Waratah liqueur, eucalypti, mimosa, native rose, and sarsaparilla, of which several deserve to be known more widely.

BITTERS AND MIXED ALCOHOLIC BEVERAGES.

Regarding these much might be repeated that we have already said in the introduction to the previous class. The same desire for change which prompts people to sweeten their means of existence impels them also to the opposite, viz, to render the same somewhat more or less bitter. We find, therefore, bitters largely as condiments to alcoholic beverages all over the globe.

Many of the substances employed are well known and applied everywhere. The more bitter a root or bark the more healthy it is considered and the more welcome. Many of these belong properly to the medicinal treasures; others are simply popular or used only locally. Novelties in this line we found comparatively few.

In the collections from the United States we can mention only celery; in those from Brazil imitations of Boonekamp played a considerable part. Besides these a Molho mineiro was introduced, quite peppery and sour, and a bitters from the Casco de Caravy a amara. Of most others the condiments were not stated nor apparent.

In the collections from Uruguay we found of merit a number of reproductions of vermouth, but this beverage, being a white wine made bitter by infusion of the herb giving it its name, did not properly come under our jurisdiction.

The same was the case with the vermouth from Italy, the country to which this liquor originally belongs. In consequence of this they were withdrawn by the representative of that State for examination in the department of viticulture. An exception was made by the submission of a vermouth manufactured in New York which deserved an award at our hands. Other and stronger bitters from sunny Italy came under our observation, however. Their "Ferment" appears to be a favorite; it is more in the character of an extract, a very small quantity of it going a great way. In Genepe we found the herbs of the Alps well pronounced, so also in Amara del Tricolla and Amara Abruzzese, the specifics of the sections. Alkermes was more distinguished by the carmine color of the insect from which its name is derived than by any other peculiarity.

A collection of bitters in the exhibit of the Sultan of Iohore, in which the Sultana Pohit was especially named, gave us no light on the materials composing it. Among those from New South Wales the appliance of hops might be considered as novel in their consideration. Medicated liquors were introduced in a limited number from Canada,

Illinois, and Italy, but to judge of their merits we would rather see them referred to the chemical or medicinal authorities. Their alcoholic parts appeared sufficiently "all right."

SAKE.

This Japanese beverage was included in the original official classification with rum and other distilled spirits, but it does not belong there. It is not a distilled spirit, but a fermented one. If it were distilled it would belong there the same as arrack, which is partly derived from the same material, viz, rice. As we had it explained, it forms a class for itself, that of rice wine. It contains but 13 per cent of alcohol—not more than many Catawba wines and not as much as ordinary sherry, to which it comes nearest in taste. Its main requirements are a handsome color—of a straw yellow—proper taste or aroma, and clearness or transparency. It is frequently used diluted by warm water. There is also a sweet kind manufactured, which is called mirim, that would suit the American taste quite well. We could not understand whether the sweetness was produced by addition of sugar or by interruption of fermentation.

FRUIT WINES AND CIDER.

The former were not generally entered to come under our observation, but of those that were, the pineapple champagne exhibited by José Elena Madiedo, of Habana, deserves the most favorable mention. It was the finest beverage of this kind that we ever had the good fortune to taste.

Several samples of cider from Spain, one of which was sparkling, were found meritorious. Others came from the Canadian northwest, from Victoria in British Columbia, but they did not arrive in the best condition.

In favor of the so-called orange cider from Florida and California, which was mainly manufactured in Chicago and mostly sold on the World's Fair grounds, we find an award entered in our lists.

FRUIT SIRUPS.

Fruit sirups were also but partially submitted to our group. Those which we had to take cognizance of came from Scotland and New South Wales, in Australia. They consisted of lime, lemon, and raspberry juices, and were of an exceptionally good character.

By special request of the representative of the Kingdom of Siam we examined the selection of pickles in that Government's collection, which were exhibited by Lady Bhaskarawongse. Marian, madan, and mango were the fruits pickled. They were exceedingly pungent, of high aroma, and well preserved.

Ceylon brought to our notice a peculiar kit of instruments used in extracting toddy, the sap of the flower of the palm tree.

VINEGAR.

This substance of universal use, and produced from any material that can undergo an acetic fermentation, was present in numerous samples, prepared in old-fashioned ways and by new processes from cider, pomace, and juices of grapes. It was introduced from the States of New York, Pennsylvania, Illinois, and Michigan; from Italy, Spain, Argentina, and Australia. Vermont showed what could be gained by the fermentation of maple sirup.

Sugar cane and its derivatives came in for a large share of attention from Brazil. Success in its production by direct fermentation from barley malt was claimed by Pennsylvania, New York, Argentina, Sweden, and New South Wales. Spirits of grain formed the basis of the five samples of vinegar from Japan, of which two were rewarded by premiums. The raspberry vinegar exhibited from Scotland also deserves mention in this connection.

GEOGRAPHICAL RECAPITULATION.

As far as the incomplete material which has been put at my disposition enables me to say, 46 countries and States were represented in group 11; in all, 311 awards were granted to the exhibitors in the same. This number represented probably from 400 to 500 exhibitors and a total of nearly 5,000 exhibits which had to be examined. Some collections contained as high as 50 different specimens, and an average of 10 to each exhibitor is probably pretty low.

It must be mentioned that, in comparison with the Centennial Exposition, the Columbian showed a considerable advance in the science of distilling, especially in the States of America to the south of us. The style of bottling and putting up, the taste displayed in the glassware selected to show off the goods to best advantage, was also far superior to what we have seen formerly. Russia, Japan, and two houses from Cincinnati excelled especially in this respect. As long as some of these goods are bought mainly for decorative purposes, it is quite essential that sufficient attention should be paid to their outward appearance.

AMERICA.

Beginning with our own continent from north to south, we found in group 11 the Dominion of Canada represented by the exhibition of cider, whisky, and medicated wine; the United States by twenty-four exhibitors—among these Vermont sent in vinegar; New York, blended whisky, schnapps, vermuth, and vinegar; Pennsylvania, straight and blended rye whisky and vinegar; Ohio, liqueurs and cordials, bottled

goods, and prune juice; Michigan, vinegar; Illinois, blended and medicated whisky, cider, and vinegar; Kentucky was represented by Bourbon whisky, Maryland by straight and blended whisky, Florida by alcohol from the cassava plant, and Massachusetts by a process for purifying liquors or spirits.

Mexico sent us a large selection of liquors, derived from various substances, from the juice of sugar cane, from the mesquite or sweet bean and the agave. They showed how most of these can be purified, deodorized, and be used to advantage. Twenty-two awards recognized the progress made in this industry.

GUATEMALA.

Two exhibitors showed by such an extensive array of rums and its various redistillations, with many known and several to us heretofore unknown aromatic fruits and other substances, that this science has reached a high grade of development in that vigorous young State. Two of its municipalities embittered our examinations by the excessive tonic qualities of their dragon blood and aloe juices.

COSTA RICA.

The successful application of aquardiente de canna (spirits gained from sugar cane) to the production of alcohol, as well as to all other distilling of fine cordials, was shown to considerable extent in the exhibits of two firms, which both carried awards.

Cuba placed itself near the head of the spirit column. Six awards and a diploma will honor the efforts of the seven firms in demonstrating that their island is not surpassed by any country in the distillation of alcohol, rum, and fine cordials. Their pineapple wine is one of the most exquisite we ever met with.

The main strength of the alcoholic productions of the Republic of Haiti lies in the distillation of bay rum. This belongs to another group, where its merits will be recognized. One sample of it strayed to our fold, and was duly awarded. Of her other exhibits, which were similarly distinguished, four were of ordinary rum, one for plum brandy, two for bitters, and one for a collection of liqueurs.

The island of Jamaica not only sustains its old reputation as one of the principal sources of good, pure rum, but it also exhibited various cordials, bitters, and vinegar, which helped to increase the number of its awards to 16, being for two-thirds the number of its exhibitors.

Trinidad obtained her usual recognition for the Angostura bitters, which makes its home there, but is known the world over. We saw no other exhibit of theirs in our group nor on record.

Curacao: We have to remark here that only one of the liqueurs bearing her name was on exhibition and was awarded a premium.

Porto Rico made a very fine showing in agricultural hall, but if it contained any objects belonging to group 11 they must have been reported on under the head of Spain, the mother country.

Venezuela displayed considerable interest in our Exposition. I find that 19 exhibits were examined, but that only one award was granted to alcohol and one to anisette coming from there.

Colombia I notice credited with but one award for a collection of liqueurs.

Ecuador: Out of five names exhibiting, one only was awarded the medal by the examining judge.

British Guiana honored us with a large selection of white and colored rum from many of her most prosperous plantations. Five of these were distinguished by awards for the superior quality of their distillations.

Brazil: The representation of this great country in the line of spirits comprised a great variety of resources for the use of distillers. They demonstrated their applicability and industry by more than 80 entries. Predominant among these was aquardiente de canna, the juice of the sugar cane. It furnished the basis of most of the alcohol, for which 5 awards were granted; for many of their bitters and cordials, which carried 13 awards, and for part of their vinegar, the other being derived from grapes.

The Argentine Republic was strongly represented in group 11. Her efforts covered all the branches of the spirit industry. The exhibits numbered 84, many contributing large collections bringing the number of specimens really examined, as in most similar cases, to a considerably higher figure. Ten of her firms obtained prizes for alcohol from sugar cane and other materials, and eight for various liqueurs, cordials, and bitters. She also furnished some vinegar.

Uruguay: Out of 15 assignments covering 19 exhibits made by 10 firms 6 were found deserving awards. These consisted of 1 for alcohol, 1 for cherry bounce, 3 for collections of liqueurs, and 1 for bitters. The vigorous enterprise of this country would appear to greater advantage if instead of imitating European brands, styles, and names, the distillers paid attention to its rich store of domestic aromatics in combination with the native material and gave them the proper credit in their appellations.

Paraguay was more independent in this respect. Among her assortment of 18 exhibits I find 3 awards granted to liqueurs of yerba, banana, and other fruits, one for rum tafia and another for bitters.

EUROPE.

Russia has proved conclusively by number of exhibits, as well as the complete range of her goods, that she is not excelled by any nation

in distillation and rectification of alcohol, pure spirits, fine cordials, and brandies from fruits of native growth. Thirty-four awards to her 37 exhibitors testified to the thorough appreciation of the high quality disclosed in her large array of samples. Not only the goods themselves, but the artistic manner in which they were displayed, added to the favorable impression they created.

Sweden did not send us a large assortment, but what they did send was excellent. We were informed that her Government before admitting any competition in their space had previously made a selection of the most meritorious. So of 6 firms submitting various brands of punch we had the pleasure to award medals to all. This punch has a world-wide fame, and sustained it at the World's Fair. The vinegar brought from Stockholm secured also a prize.

Denmark: From Copenhagen we could only welcome two firms, but their productions, arrack punch, cherry brandy, and gooseberry or stickelbeer brandy, stayed in the front rank of their kind and carried awards for both houses.

Germany's participation in this great review was not in keeping with her successful efforts in other directions. Only the Grand Duchy of Baden proved by a full line of her fruit brandies what gain can be made from her orchards and the cherry trees grown by the wayside. Other parts of Germany were awarded 11 medals for different kinds of liqueurs and bitters, one of which was for whiskies purified by refrigeration. The principal source of the spirits produced in Germany is derived from the potato and beet, although rye is also largely used.

Austria, so well prepared to meet competition in the field of spirits, did not consider this a promising occasion to show her strength. While some of her distillates are known and imitated the world over, we found but few of the original producers claiming their proper distinction. Two of these, however, were justly recognized.

Switzerland, the home of some of the most popular distillations, only sent us three to judge the rest by. One award was decreed for Kirschwasser, the other for absinthe, which comprise the principal staples under our rubrics.

Great Britain showed its strong hand in several of the leading branches. The Scotch and Irish whisky and blended whiskies introduced from the United Kingdom, its gin, lime juice, and raspberry cordials, and vinegar, carried awards for over one-half her exhibits.

The Netherlands, the home of gin, genever, or schiedam schnapps, had but few representatives in this line, which forms one of the principal articles of their export to this country. Its high quality was discerned by proper awards; one for arrack, one for gin, cordials, and other liqueurs. Another of their exhibits did not come into competition because the party interested in its production was one of the judges.

Belgium acting in conjunction with France had both withdrawn all their exhibits in every department from competition for prizes. We were sorry to have been prevented by this action from according their products in our line such consideration and recognition as they undoubtedly deserved.

Italy sent a splendid array of high-grade distillations. Not only her well-known specialties the fermet, genepe delle alpa, aqua tutto cedro, and alkermes, were fully represented, but also very successful imitations of French brands of cognac and so many other genuine cordials, fruit brandies, bitters, and local productions as to warrant the distribution of 14 medals and the according of 8 diplomas. Two premiums were granted to some of her choice vinegar.

Monaco introduced from one firm a collection of liqueurs in the style of the French, which came as near to their prototypes as can be demanded, besides presenting some fine specialties of their own. The principality also sent a line of lemonade gazeuse, which had suffered, however, in transportation.

Spain manifested great activity in the production of spirits. Of her distillates 55 were submitted to examination. Of these 2 samples of alcohol, 3 of rum, and 1 of anisette were reported by the judge for awards. Three were given for cider and 12 for vinegar.

OTTOMAN EMPIRE.

The Ottoman Empire had but one collection of exhibits in our group. This came from the island of Samos. It consisted of cordials delicately flavored by native herbs.

ASIA.

Japan honored itself and the Columbian Exposition by presenting 47 brewings of their rice wine, sake, 3 of which were for the sweet variety called mirim. Thirty-two awards were allotted and 2 for vinegar, of which 5 samples had been submitted of a quality which would compare favorably with that from any other source.

AFRICA.

Africa was a real dark continent for us. Its neglect by American industry and occupancy by European activity was illustrated in the total absence of any product in our group, with the exception of some spirits or brandies of Algerian origin exhibited in agricultural hall. From the examination of these we were prevented by the nonconcur- of France and their entry under viticulture.

AUSTRALIA.

New South Wales was the only one of all the colonies among our antipodes which exhibited a lively interest in the World's Fair. Her

participation disclosed considerable success in distilling, and surprised us by the extent of their assortment.

From Sydney and Nowra we found 4 exhibitors presenting collections of cordials which for novelty, lemon sirups which for quality, and vinegars which for strength could vie with any older country. They received 3 awards.

The Australian rum from native sugar cane, of which 1 sample was introduced, did not come up to the standard established by the West Indies.

From the published statistics of special industries in the United States, according to the census of 1890, the following figures are extracted:

Liquors, distilled.

Number of establishments reporting	440
Capital:	
Aggregate	$31,006,176
Value of plant:	
Total	16,972,727
Land	2,816,967
Buildings	6,299,511
Machinery, tools, and implements	7,856,249
Live assets	14,033,449
Miscellaneous expenses	65,179,927

Average number of employees and total wages (aggregates).

Average number	5,343
Total wages	$2,814,889

OFFICERS, FIRM MEMBERS, AND CLERKS.

Number males above 16 years	573
Wages	$564,325
Females above 15 years	8
Wages	$4,500

OPERATIVES, SKILLED AND UNSKILLED.

Males above 16 years	4,559
Wages	$2,142,232
Females above 15 years	3
Wages	$390
Number children	5
Wages	$540
Cost of materials used	$14,909,173
Value of products, including receipts from custom work and repairing	$104,197,869

HISTORY OF THE VINE, THE GRAPE, AND THE WINE.

By E. DUBOIS.

The culture of the grape is ancient as the World, although it can not be traced further back than some time after the flood, in connection with Noah and his family. All through the Bible is found mentioned the planting of vineyards and drinking of the wine. The vine, "*Vitis vinifera*," was imported into Greece from Asia by the Phœnicians, and from Greece it spread all over the southern and middle countries of Europe and the northern part of Africa. It seems to have been introduced in Italy prior to the foundation of Rome (800 years B. C.), as it is said that Romulus forbade the libations of wine which were in use in all the sacrifices to the gods. It was Numa who first permitted it, and Pliny says that favoring and encouraging grape culture was one of the means made use of by politicians to gain popularity. Wine soon became so abundant that the people could make a free use of it, and the fair Romans were accused of going too far in that enjoyment. That abuse by the ladies of the land caused a law to be enacted by which women were forbid to drink wine under penalty of death, but the excessive severity of the law was an obstacle to its enforcement, and soon after it was amended so as to fix at the age of 30 for both sexes the right of drinking wine. Before long they found out that even that restriction was too great on the use of such a precious product which had become more and more plentiful and popular, and they were obliged at last to leave its use entirely free.

The foregoing shows that the prohibition cause had some adepts eight hundred years before Christ, but it shows also that then as now all restrictive measures enacted proved a complete failure.

WINE.

Wine is the fermented juice of the grape. All so-called "unfermented wines" have no right to that title, nor have the fermented juices of other fruits. White wine is generally obtained by pressing out the juice of white grapes, but in the making of some wines, such as champagne for example, some particular grapes are also pressed without allowing the juice, or must, to remain in contact with the skins any length of time; thus a wine is obtained which, although lightly tinted in red, will blend well with the must from white grapes,

and impart to the latter more tone and life. For red wine black grapes are crushed, and juice, pulp, skin, and stem are allowed to ferment together for a period of time varying from two to fifteen days, according to varieties of grapes, country temperature of fermenting room, etc., and often also to the skill or ignorance of the vintner. Sometimes the stems are eleminated from the fermenting vat by the operation know as "stemming," which is practiced when working varieties of grapes with stems out of proportion with the berries, or still green when the grapes are ripe, which is the case in most of our American varieties.

We shall not in this report, which must necessarily be succinct, give the chemical constituents of wine, or discuss the erratic statements of laboratory wine makers who pretend to determine the quality and commercial value of wines by analysis.

There are different theories as to what constitutes a pure wine, some contending that no wine is pure except that made entirely from grape juice, and that any substance whatever, added before, during, or after fermentation, even for fining purpose, is an adulteration. The legislators of the State of Ohio in this country went still further. In their "pure wine bill" they declare the blending of two or more pure wines together to be an adulteration! In our mind, all treatments in view of improving the quality of the wine, or producing certain types of wine, should not be considered as adulteration, as long as deleterious matters are not introduced in the wine. In the manufacture of port or sherry, for instance, spirit is added to produce the kinds of wines known as such. If it be grape spirit, the wine for us will remain a pure wine; but should grain or other kind of spirit be resorted to for the fortifying, we would call that "adulteration." In the latter case, the aim is not to improve the quality but to lower the cost of production.

Some qualities or defects in the wine are inherent in the variety of grapes it is made of, some others in the soil on which these grapes are grown, while the location of the vineyard and atmospheric conditions modify these inherent qualities or defects. Consequently, the same variety of grape will not produce in different soil and climate the same quality of wine, but the main characteristics of that grape will, in a certain degree, be found in that wine. A Cabernet wine will everywhere possess more or less of the Cabernet flavor—delicate and refined in some locations, strong, rank, and common in others.

VITICULTURE IN THE UNITED STATES.

I. REGION EAST OF THE ROCKY MOUNTAINS.

Although it is supposed that the first attempts at grape growing and wine making date from the time the first European settlers came to this country, it was not before the end of the last century that such

experiments were made from a business standpoint. At Spring Mill, on the Schuylkill, near Philadelphia, Mr. Legaux, a Frenchman, planted a vineyard in 1792 or 1793; and later on Philadelphia capitalists entered into partnership with Mr. Legaux and established a stock company for the extension of that vineyard. On President Jefferson's place, in Monticello, a vineyard existed at about the same epoch. In 1799 a company with a capital of $8,000 was formed between a Swiss vinedresser, John James Dufour, and some parties from Lexington, Ky., for the planting of a vineyard in the vicinity of that city. Thirty-five varieties of grapes, mostly of European origin, were set out, all of which proved worthless and perished with the exception of one, known then as "Cape grape." This variety had been, according to Mr. Legaux's statement, imported by him from the Cape of Good Hope, but reliable authorities, less interested in the matter than the propagator, claimed that it had been discovered by Alexander, gardener to Governor Penn, on the banks of the Schuylkill near Philadelphia, before the War of the Revolution. In 1802 some Swiss colonists had also planted vineyards near Vevay, Switzerland County, Ind., on the banks of the Ohio River, forty-odd miles below Cincinnati, confining their planting to the Cape grape. In 1816 Mr. John James Dufour joined the Swiss colony, and through his skill as a vinedresser and vinter they produced a pretty fair wine of the claret sort, which soon became very popular.

We shall not undertake to relate the different phases of the grape and wine industries up to date. Suffice it to say that Catawba was the next favorite wine grape, and that its introduction gave a new impetus to those industries. When, later on, mildew and black rot rendered that grape unprofitable to grow in Ohio and other Western States Ives was proclaimed the great wine grape of the country. Although Norton's Virginia Seedling had been introduced some thirty years before, on account of the small size of its berries and bunches it did not attract the attention of the American grape growers, who, for a long time, as a rule, had a strong predilection for big monstrosities, and that little, insignificant grape was not much made use of for the manufacture of wine prior to twenty or twenty-five years ago. It is now considered, with the Cynthiana, the best native red-wine grape in this country.

Unfortunately, those two varieties can not be cultivated on so large a range as some of the grapes of inferior quality, such as Concord and Ives, and their yield is rather small. For the production of white wine Catawba and Elvira take the lead, the former especially in the Northeastern States, the latter in the South and West. Many other varieties of grapes are used for wine making, several of which, however, have none of the requirements of a wine grape.

All the foregoing remarks refer to that portion of the United States lying east of the Rocky Mountains, where all attempts at growing European grapes have proved futile.

The viticulture of California will be the subject of the following chapter.

II. VITICULTURE IN CALIFORNIA.

There is no country in the world where, in the same area, so many different varieties of grapes can be raised successfully. There are found the grapes cultivated in France, Spain, Italy, Hungary, Asia Minor, Northern Africa, etc., all ripening to perfection, all producing wines which, if not as yet up to the highest standards of those from the above-named countries, already rank next to their best, and far surpass their ordinary products.

The following paragraphs, borrowed from the report made in 1888 by Mr. Arpad Haraszthy, president of the California State board of viticultural commissioners, give the history of the grape industry in California:

The old Mission fathers planted the grapevine in California immediately or shortly after their arrival, previous to 1770. They planted small tracts close around their Missions, guarded them jealously with high adobe walls, cultivated them carefully, gathered their fruit, and made wine. These wines, so far as we can learn, did not enter into the trade of those days, but were consumed by the good fathers, their occasional visitors, and their immediate retainers. Even after the arrival of Americans in 1849, and with them representatives from every civilized nationality on the globe, but little advance was made toward increasing the area of viticulture until the year 1858, when, through the publication of vine articles in the reports of the State agricultural society, and in the newspapers, a general and widespread interest manifested itself in vine planting, and the area of our vineyards became very greatly increased. A very large proportion, however, of these new plantations consisted of table-grape producing vines, and the remainder was almost exclusively composed of the old Mission variety.

Toward 1862 vine planting arose to a genuine enthusiasm, and a lively interest was shown in selecting better varieties for the table, for the wine press, and for raisin curing.

Of the three commissioners appointed by Governor Downey in 1861 "to report upon the best means and ways to promote the improvement and culture of the grapevine in California," Don Juan Warner returned a clear, concise report on the state of vine culture at that period within the limits of our State. On the other hand, the late Agoston Haraszthy went to Europe, and after visiting all its most important viticultural districts, made an elaborate report on the European methods of cultivating the vine, making wine, and curing of raisins, adding practical suggestions to the California vine grower, and at the same time bringing 200,000 grapevine cuttings and rooted vines of every attainable variety to be found in Europe, Asia Minor, Persia, and Egypt. These were afterwards gradually distributed in small lots to different parts of the State, and formed invaluable nuclei for experimentation. No report was ever received from the third member of the above commission.

Toward 1870 the production of wine and table grapes became greater than the demand, and our viticultural industry began to lag, and finally became so discouraging that in 1875 many vineyards were either abandoned, uprooted, or replaced by orchards and grain fields.

In 1879 the demand for table raisins and wine grapes caught up with the supply, and a renewed interest was awakened in viticulture. Our raisins were looked upon with charity in the East. our rich clusters of table grapes admired and sought for,

while our wines, though still very crude, had found more numerous and less exacting customers.

Up to 1880 those who believed in the value of varieties of grapes for wine making, other than the old Mission, were few and far between. With the exception of a very limited number of vine growers, none believed any grape could be as good as the Mission, and we have even at this date a Quixotic spirit existing in some parts of our State, still advocating the planting of this very poor, quality-lacking grape.

Experience has shown that it only produced an ordinary, coarse, heavy, flavorless white wine, taking an indefinite period to mature. Such questionable qualities as it may possess in the production of a white wine are more than overbalanced by the miserable red wine made from it. And to this cause, more than any other, I attribute the bad reputation our wines had earned, both here and in the Eastern States, previous to the more general planting of other and finer varieties of grapes.

Many claims have been made by the admirers of the Mission grape, but none have been proven. It bears unevenly, ripens unevenly, and takes upon itself almost every disease that comes along. In this respect we have to congratulate ourselves, for soon the phylloxera and the grafting knife will have rid us of its presence in our vineyards. In point of fact, most of our vineyards are now planted with vines more hardy, resisting disease better, more constant bearers, producing finer qualities and greater quantity than the Mission ever succeeded in doing under the most favorable conditions. Through the persistent efforts of a few enterprising viticulturists, small quantities of wine have been produced from the imported varieties, whose character was so distinctive and so strikingly showed superiority over those made from the Mission, that new faith in the future of California wines was born, and the belief spread that under proper conditions our State might some day make wine of a superior grade, and eventually rival some of the better wines of European countries.

At the beginning of 1880 our viticultural interests were in a complete state of chaos. In spite of the efforts made by our wine makers and wine merchants, only a limited market had been secured for our wines in the Eastern States, and though the demand showed a steady annual increase it was at the slowest of rates. Even that small increase, however, was considered gratifying and hailed as encouraging.

The crop of the year 1879 had been a short one. The old stocks had been exhausted, and suddenly the price of all kinds of wine went up, and the supply was barely sufficient to meet the demand of the market.

This awakened the more general interest of the public in vine planting, but there was a woeful lack of knowledge, a want of system, no beaten paths to follow, and but a few acknowledged authorities to apply to for information. Numerous newspaper articles appeared calling attention to the value of viticulture in our State, and expressing the desire for the formation of some State institution where such practical knowledge might be obtained as was necessary to the successful conduction of this important branch of agriculture.

Under these influences, soon after, the State legislature took the matter under advisement, and in March, 1880, the State board of viticulture was created, and provided with a modest fund to meet its necessary expenditures.

The numerous duties falling to this board are fully outlined in the organic act, then created and approved April 15, 1880, and enlarged in 1881, and which you will find in our first annual report, on pages 5, 6, 7, 8.

Under this act the State was divided into seven viticultural districts, each having a representative in the board, appointed by the governor, and chosen from among men practically conversant with viticulture in its various branches, and recognized in their districts as suitable for the position.

Besides the commissioners from these seven viticultural districts, there were to be appointed two extra commissioners to represent the State at large, thus forming a board consisting of nine commissioners. The officers of the board were to consist of

a president, a vice-president, a secretary, and a chief executive health officer. No salary was allowed any of the commissioners or officers, except the chief executive officer and the secretary, the rest of the board serving without compensation.

It was understood that the governor of the State having the appointment of these men would choose those who were best adapted to fill the post of honor without regard to social position, creed, or politics, and though the terms of three governors have ended, this understanding has been honorably maintained up to your administration.

The original appointments were made, and the several commissions signed by the governor April 19, 1880, and immediately upon receiving notice to that effect the commissioners assembled, organized the board, and shortly afterward began their labors.

The work of this commission and the method with which it was carried on was so well appreciated by the succeeding legislature that it created a State board of horticultural commissioners, under similar laws as those of this board, and put the same under the direction of the viticultural commission to take charge of, together with the funds appropriated for its maintenance.

The horticultural commission was supervised by our board during the term of two years, and the result of their supervision proved itself satisfactory both to the horticulturists and the public at large. Owing, however, to the additional work thus thrown upon this board, it appealed to the legislature to relieve them of the charge and allow the horticulturists to conduct their own board as they might think best. This was acceded to at the following term of the legislature.

At the time of the organization of the viticultural commission it was estimated that there were 35,000 acres of vines planted in the State. I am inclined to accept these figures as correct. Of this amount there may have been planted as much as 20 per cent with imported varieties and the balance with Mission grapes.

At the present date, after eight years' existence of the viticultural commission, it is believed that there are planted not less than 150,000 acres in vines, and fully 90 per cent of these are reckoned as consisting of the finer grades of foreign wine grape varieties, mainly drawn from France, Spain, Portugal, Italy, Germany, and Hungary. The result of the planting of these fine grade grapevines has been the producing of wines of much better quality than had been hitherto produced, creating a revolution in favor of California wines and the conquest of markets that even the most sanguine among us never hoped to acquire.

To see the wonderful strides made by the California wine trade since that report was published, a glance at the figures below will be sufficient. In 1875 (the first record we have of the exports of California wine) the total wine shipments out of the State had been 1,031,507 gallons. In 1887, the year before the publication of the report, they amounted to 3,140,305 gallons. In 1893 they reached 12,326,033 gallons. A considerable increase in the export of cased wines dates from 1891, when from 5,485 cases in 1888, 5,659 in 1889, and 9,058 in 1890, the number of cases shipped by sea reached 14,289, the increase on overland shipments being probably in the same proportion, although there is no record of these previous to 1891. In 1893 the export by sea and by rail overland aggregated 51,046 cases.

BRANDY.

Brandy is the product of the distillation of wine. The typical brandy is that known all over the world as "Cognac brandy" and is

produced in two departments of France—Charente and Charente-Inférieure. It takes its name after the city of Cognac, located about in the center of the best brandy district. These districts or "crus" are: Grande Champagne, comprising 21 communes, with Segonzac as principal center. The brandy from that district is full-bodied (corsé), absolutely clean in taste, with a powerful, although delicate, bouquet developing with age. It will not mature as fast as the product of the other districts, but will keep improving for a much longer period than the latter—in fact, almost indefinitely. Petite Champagne, embracing 55 communes. Its brandy has all the qualities of that of the Grande Champagne, but in a lesser degree. Its principal feature is a great delicacy of bouquet. Bordinés, smaller in area than the other districts, produces a brandy with great body and character. Fins Bois, a district comprising a stretch of country, irregular in shape, surrounding the 3 above superior crus. Its brandies vary a great deal in quality, but have in common a great cleanliness of taste, purity of flavor, and mellowness. Bons Bois, the adjacent territory to the Fins Bois, extending more or less from the boundaries of the latter, forms the Bons Bois district, which is said to be composed of over 350 communes, not without including, however, what is also known as Bois Ordinaires.

The brandies from such an extended territory can not fail to differ greatly in flavor, body, etc.; as a rule they are drier and "cut shorter" than the Fins Bois, although in some localities brandy is found with great mellowness and fine bouquet, lacking only in tone and body. Besides these five principal crus, brandies are produced in the northwestern part of the Charente-Inférieure, which, although of an inferior quality, are in great demand for and are used in all those cheap blends with beet or potato alcohol which are palmed off as cognac on the gullible foreigner, often prejudiced against his native pure and wholesome grape brandy.

These brandies are known in France as Surgères, Aigrefeuille, La Rochelle. They all possess, to a more or less degree, a decided "goût de terroir;" that is, a peculiar and implicitly objectionable taste varying in the different localities and increasing as they near the seacoast. This "goût de terroir" wears off with age, and as they ripen much faster than even Bons Bois, old Surgères and Aigrefeuille brandies are often sought for to give the necessary "rancio" (nutty taste) to blends of younger but finer ones.

Different countries, Italy, Spain, Greece, Australia, California, etc., have tried to produce brandies to compete with those of France. Good and encouraging results have already been obtained when the attempt was made on a small scale, but the bulk of these brandies sold to the trade being mostly made from spoiled wines, old and young, and from lees and pomaces, have nothing in common but the name with the genuine article they aim to compete with. Some houses in Australia and

California, especially in the latter country, by a judicious selection of the wines they distill have made a name for their brandies. So long, however, as these firms persist in using distilling apparatus that rectify the brandy to death by eliminating all ethers and essential oils, which not only impart to the brandy bouquet and flavor but also mellowness, so long will they produce the dry, thin, neutral article to which no doctoring will give the cognac "altogether."

THE WINES AND BRANDIES OF THE WORLD.

There never was at any former international exposition so fine and complete a display of the wines and brandies of the world as could be seen at our great Columbian World's Fair.

Spain had secured, as she was entitled to at a Columbian Exposition, the most favored location, at the south end of the immense flower conservatory. The inclosure in which her wines were displayed was formed of arches in the Moorish style, decked with garlands of vines, and the innumerable bottles on pyramidal shelves, together with the more substantial hogsheads and barrels painted in the national colors of Spain, were of great decorative effect. There every province of Spain was represented by its viticultural products: Cadiz by its inimitable Jerez wines; Cordova by its Montilla; Ciudad Real by its fine Valdepeñas; Barcelona, Terragona, and Valencia by their "vins de coupage;" Biscaya by its pretty red wines; Navarra by its cheap, common wines, many of which, however, are not without merit; Malaga by its "vinos dulces." It was indeed a most remarkable collection, showing the great possibilities of Spain for the production of all sorts of wines, ranging in prices from 8 cents per gallon and 60 cents per dozen bottles (see official Spanish catalogue, "Vino tinto de mesa," from the province of Cuenca, No. 874) to $4 and $5 per bottle.

South of Spain, occupying the southeast corner of the building, was the French section. Here was no attempt to decorate; no individual effort to make a special brand or firm more conspicuous. Uniform, vertical showcases and double-sided shelves contain all the wines, brandies, and liqueurs forming the official collective exhibit. Probably the French commissioners who presided at that arrangement thought that, as the proverb says, "Bon vin n'a pas besoin d'enseigne." It was a matter of regret for the wine jury, and for all interested in or admirers of French wines, that France withdrew them from competition, as well as other products. A wine jury without the wines and the brandies of France for its guidance is about like a boat without a rudder. We noticed, however, and this with no little surprise, that the most prominent Bordeaux houses, even those doing large business with this country, had not sent any exhibit. I call that bad policy.

Never before had French wine houses, and especially wine merchants from Bordeaux, more reasons for pushing their wines and keeping

them constantly before the American public by judicious advertising. Why not avail themselves of that great advertising scheme?

The new tariff was being discussed, and there was already then a probability that the duties on light wines would be reduced. Italy and Spain were and are working hard to introduce their wines as substitutes for French wines, and Italy has already succeeded in a certain measure. We know the "grands crus" of France do not fear any competition, but France ships to this country other grades of wines. Why not have seized that opportunity to place those wines in competition with the brands from the two other countries referred to? It would have had better results than petitioning the French Government for a commercial treaty with the United States.

In 1888 France exported to the United States, via New York: Bordeaux and Burgundy—in wood, 430,180 gallons; in glass, 111,045 dozens. In 1893: Bordeaux and Burgundy—in wood, 368,220 gallons; in glass, 107,420 dozens. Decrease, 41,960 gallons and 3,616 dozens.

In 1888 Italy exported to the United States, via New York: Italian wines and vermuth—in wood, 69,210 gallons; in glass, 35,637 dozens. In 1893: Italian wines and vermuth—in wood, 186,010 gallons; in glass, 54,702 dozens. Increase, 116,800 gallons and 19,065 dozens.

The importation of Cette wines fell from 132,740 gallons in 1888 to 31,120 gallons in 1893. California and Italian wines have taken their place. Cognac houses were awake to the perils of the situation. All the first-class brands were represented. They knew their products have on the American market a formidable rival in the California brandy, the quality of which is constantly improving. The importation of Cognac brandy at New York was, in 1888, in wood, 208,332 gallons; in glass, 42,290 dozens; in 1893, in wood, 119,842 gallons; in glass, 30,936 dozens, showing a decrease of 91,490 gallons and 11,354 dozens. The shipments of California brandies to New York were, in 1888, in wood, 33,689 gallons; in 1893, in wood, 285,531 gallons, showing an increase of 251,842 gallons.

Although champagne shippers are not threatened with any dangerous competition, some of the first-class houses were represented, prominent among which were G. H. Mumm & Co., of Rheims, with a splendid individual exhibit. Four French firms, namely, G. H. Mumm & Co., already mentioned, Ruinart père et fils, Théophile Rœderer, all champagne houses, and Marie Brizard & Roger, of Bordeaux, protested against the withdrawal of French products from competition and applied to the department of awards for an authorization to enter their products. The authorization was granted, and the wines of G. H. Mumm & Co. (extra dry) and Ruinart père et fils (vin brut) were each awarded a medal and diploma for excellence. The same distinction rewarded Messrs. Marie Brizard & Roger for their superb collection of fine old Cognac brandies and liquors.

Near the French section, in the bay at the east end of the building, could be seen the banner of New South Wales. Although a comparatively new wine-producing country New South Wales has a most creditable exhibit, which will be made the subject of a special report. Near by was Mexico, with their wines, brandies, and tropical fruits. Farther Russia, whose Crimean, Bessarabian, and Caucasian wines are from year to year improving owing to the introduction of better varieties of grapes and improved methods of vinification. Some pretty good table wines are produced in Crimea and Bessarabia and a few brands of Russian champagne were entirely free from that sui generis Caucasian flavor noticeable in so many Russian wines, and found to possess the inherent qualities of good sparkling wines.

About in the center of the building were located several individual exhibits from the States of New York, New Jersey, Ohio and Missouri, most of them hastily arranged. If, however, a prize had been given to the finest and most distinct exhibits, California would have won by long odds. The Big Tree, the Big Vat, the Vina Vineyard and Alameda County exhibits were such as to attract the attention of the public by their originality and good taste at the same time. The west end of the building was occupied by the exhibits from New Mexico, North Carolina, Canada and Japan.

Upstairs, in the galleries, Portugal's most complete exhibit occupied the southeast corner. Opposite, an annex of the Spanish section consisting mainly of brandies and liqueurs. Then was Chile with its artistic display of fine wines, and Greece with plain rows of bottles, on shelves. Next, the collective exhibit of the State of New York was a model of taste and contained a very interesting collection of apple and grape brandies, besides wines of various sorts and denominations. Finally, occupying the whole west end of the galleries, came the Italian section. Italy is now the largest wine-producing country in the world, and a study of its different types of wine would have been particularly interesting for the writer, but being busily engaged elsewhere he was deprived of that pleasure. All ultimate attempt to obtain private sitting and sampling proved futile, owing to the Italian commissioner in charge being unable to devote any time to it.

THE WINES OF GERMANY.

Germany occupies the sixth rank only among the wine-producing countries of the world for the quantity of wine produced, but when the quality of its wines is considered she has rivals, but no superiors. While it can not be said, as some admirers of Rhine wines pretend, that they surpass all other white wines and that Schloss Johannisberger is superior to Château Yquem, it must be admitted by all that among the light white wines of the world, Rhine wines on one side and Sauternes wines (including the growths of Barsac, Preignac, and Bommes)

on the other, respectively stand as the best types in that line All the other countries aim only at an imitation of these two different types in their production of light white wines.

The history of the culture of the grape in Germany dates from way back in the first centuries of our era. It is said to have been introduced by the Romans, but proofs exist that grape culture was known and engaged in in the Moselle districts before the Roman invasion. We heard that it was introduced into Bavaria by the Duke Merwig, who, in the year 460, ordered grapevines to be planted by seven hundred prisoners of war coming from the Moselle.

In Franconia there is a pretty legend attached to the introduction of the culture of the grape in that province:

Adeloga, a pretty girl of 18, sister of King Pipin, was one day standing at the open window of her castle on the summit of the Schwanberg, holding in her outstretched hands a veil light as the vernal air. It was a warm summer day and all nature seemed to be asleep. Suddenly a heavy puff of wind blew the veil away from her hands and carried it over a long distance on the bank of the Main. Adeloga, swift as a gazelle, ran after the veil and found it hanging on the limbs of two shrubs entirely unknown to her; one was covered with golden fruit hanging in long and large bunches, the other with the same kind of fruit, but blue as the sky above her head.

The young damsel gathered some of these fruits and showed them to a hermit who lived in the forest near by and who had come from very far distant countries. The hermit told her that the shrubs were grapevines and the fruit bunches of grapes.

Adeloga thought it a sign from God and caused a convent to be built on the spot where the veil had fallen; thus the Benedictine Abbey in Kitzengen on Main was erected, of which she became the first abbess and devoted herself to the culture of the grape.

Soon it spread all over Lower Franconia, and thus it is that we can enjoy now those delicious Stein and Leisten wines which their fineness, mellowness, bouquet, and vitality class among the grand wines of the world, side by side with the best growths of the Rheingau, and others mentioned in the following report:

REPORT OF THE GERMAN WINE JUDGES AT CHICAGO.

From the Moselle and Saar district about 190 samples have been sent, of which the full-flavored Saar wines, and especially the Scharzhofberger, as well as the aromatic and mild Josephshöfer, raised the greatest admiration; not less successful were the Bocksteiner, Eitelsbacher, Herrenberger, Berncastler, Piesporter, Trabener, Brauneberger, etc., which have been recognized as highly elegant wines; further, the Erckner, Winninger, Uerziger, Eukircher, etc., which for their fine bouquet and lovely character have found a well-justified appreciation. Part of the American judges considered these wines somewhat light or thin; others, and particularly the German ones, made no restriction to their high appreciation.

The wines of the Nahe were represented in about 80 varieties of generally good, partly very good growths, and with particular merits for the Rothenfelser, Kautzenberger, and Mönchberger.

Exhibitors of the right and left side of the Rhine, below Rüdesheim and the Nahe, have sent well-flavored Assmannshäuser, full-bodied Lorcher, and charming Bodenthaler and Bacharacher wines.

The Rheingau wines have been represented by a great number of prominent producers of this district; most of the firms of the Rhenish wine trade have made a good display of the same, and have shown together about 320 samples. The highest degree showed the choice growths of Rüdesheim, which answer fully to the American taste, being full-bodied, finished, and very aromatic. Beautiful wines were also furnished from the best districts of Geisenheim, Johannisberg, Winkel, Oestrich, Rauenthal, Erbach, Hattenheim, Hocheim, etc., wines which are, through their fine boquet and excellent quality, without rival in the world. There were all great vintages from 1706, 1811, etc., up to date, but the wines of 1886 were preferred for their remarkable freshness, which is much liked in America.

The Palatinate was well represented by the large vineyard proprietors of the middle Hardt mountains and the wine merchants of that district. About 160 samples were on hand and met with much success. The extraordinary richness, sweetness, and fullness of these wines, together with their powerful aroma, were particularly recognized in specimens of Deidesheim and Forst, of which the most beautiful samples were at the disposal of the jury.

From Lower Franconia the proprietors of the best vineyards of Stein and Leisten, and other fine growths, were anxious that their districts should be represented according to its merits. For this end they showed not only the recent vintages, but also wines from 1783, etc., which were, indeed, remarkable rarities.

Wurttemberg, which had at first sent lots of samples, which, however, were destroyed by the fire in the cold-storage building, was at the general tasting only represented with a few samples of which the wines of Heilbronn, Weinsberg, Lauffen, and Hofhammer were particularly worth noticing.

Baden had plenty of samples, and they were well received. The full-bodied wines of Ihringen, Burbach and Castle Neuweier, and especially the Margräfler, which were represented in many vintages back to 1766, and the full-flavored, red Affenthaler, were to the jurors highly agreeable surprises.

The wines of Hessen—184 samples—were not only contributed by the commerce and the wine growers of Hessen, but many other exhibitors had Hessian samples among their collections. On the other hand, its production was pushed by the Landwirthschaftlicher Verein (agricultural society), well represented in all qualities from light, cheap wines, up to the highest degrees. The jury praised all these kinds, appreciated the very good quality of the light wines of the Rhine-Hessian Palatinate, as well as the mildness and character of those wines grown on the Rhine, and admired the noble richness of the Oppenheimer and Niersteiner first-class growths, the world-renowned Liebfrauenmilch and the elegant style of the Kaupterberg, the fullness and superior flavor of the Scharlachberg; chiefly the latter wines were found highly in accordance with the American taste.

Only very few samples of Alsace-Lorraine had been replaced, but those few samples showed well how much pain and care are displayed in cultivating the wines and their handling and maturing; Rappoltsweiler particularly was favorably represented through beautiful Riesling wines. The claret wines, which are used to produce sparkling wines, prove careful and well understood treatment.

A very prominent part in the collective wine exposition was taken by the sparkling wines from all German districts, and the jury awarded them prizes without exception. Even those firms which were out of competition had sent most beautiful samples, and we may say that the success of these wines was very great and well merited. Most houses showed two different qualities, one in the style of the French Champagne and produced by the same grape—Burgundy grape—and one produced from Riesling grapes, which shows the character of this wine particularly well. The first-named quality is preferred in Germany, and seems to be in America, too, being made up "dry," the favorite sparkling wine among Germans; but the latter quality is much liked in England and the English colonies as Sparkling Hock and Moselle

has many friends among English-Americans. There is no doubt that German sparkling wines would find a good market in America if those houses who want to introduce them, would, for advertisement, risk as large an amount as their French competitors do, but to this purpose the German sparkling wine trade would have to strengthen itself, in the first instance at home, at such a rate that these houses could easily spare similar large amounts.

German red wines, not being of such great importance, were not very numerous; some firms had only one sample added to their collections, and thus it was difficult to form an opinion. Nevertheless we showed these red wines of different districts, and the result was very satisfactory. Baslen has its recognized Affenthaler, Hessen its excellent Ingelheimer, Rhenish Prussia and the Rheingau the high-flavored and full-bodied Walporzheimer and Assmannshauser.

THE WINES OF PORTUGAL.

Portuguese wines do not seem to have had a great reputation abroad before the year 1689, when England became involved in a war with France. English wine merchants, unable to procure from that country their usual supply of wines, imported some of the red wines of Portugal which, the hatred of France helping, soon became popular, and remained so ever since.

The wine generally known as port wine is highly alcoholized; not as much so now, however, as it used to be, owing to an active crusade of all lovers of natural wine and a change in the taste of the wine-drinking public in favor of lighter wines.

Baron Forrester, a wine grower in Portugal, and a recognized authority on port wine, described as follows the method practiced some thirty or forty years ago in the manufacture of port:

To produce black, strong and rich wine, the following are the expedients resorted to: The grapes being flung into the open vat indiscriminately with the stalks, sound and unsound, are trodden by men till they are completely mashed and then left to ferment. When the wine is about half fermented, it is transferred from the vat to barrels and strong brandy is thrown in in the proportion of 12 to 25 (?) gallons to the pipe, by which the fermentation is generally checked. About two months afterwards the mixture is colored thus: A quantity of dried elderberries is put into coarse bags; these are placed in vats and a part of the wine to be colored being thrown on them they are trodden by men till the whole of their colored matter is expressed, when the husks are thrown away. The dye thus formed is applied according to the fancy of the owner, from 28 to 56 pounds of the dried elderberries being used to the pipe of wine.

Another addition of brandy of from 4 to 6 gallons per pipe is now made to the mixture, which is then allowed to rest for about two months. After the end of this time it is, if sold, sent to Villa Nova, where it is racked two or three times and receives probably 2 gallons more of brandy per pipe, and is then considered fit to be shipped to England, it being about nine months old. At the time of shipment 1 gallon more of brandy is usually added to each pipe. The wine thus having received at least 20 gallons per pipe is considered by the merchant sufficiently strong.

Not satisfied with these 20 gallons of adventitious spirit per pipe, the English merchant often fortifies his port wine in bond by what is known as an "operation."

Some fifty years ago the cry was for color! color! and prior to that time "tawny port" was in demand as it is in demand now. Many who discountenance the practice of fortifying port wine are not familiar with the difficulties attending the fermentation of red wine in Portugal.

The fortifying of the Alto Douro wines, if practiced with moderation, will precipitate all impurities held in suspension in light wines exposed to a high atmosphere when their fermentation has been laborious and defective; it will by combining with free acids, react upon them and form ethers which impart to the wine the bouquet of the grape. By many other mechanical actions it will also give the wine a roundness and softness seldom found in the unfortified wines of a hot climate. It should be borne in mind that even at their best the red wines of Portugal, thoroughly fermented and unfortified, will be lacking in that freshness, delicacy of bouquet, and suavity of flavor which make the first growths of Bordeaux so famous. But the principal consideration militating in favor of the light fortifying of fine Portuguese wines is that a unique article is produced for which a taste exists and high price is paid.

The following report on Portugal wines, by Alphonse Le Duc, will be of interest:

Portugal is justly celebrated for its generous full-flavored port wines, which are produced in the Alto Douro district, a rugged mountainous country, necessitating the construction of terraces supported by walls to prevent the soil being washed away by winter rains. The climate is very cold in winter, but extremely hot in summer; this, combined with soil of argillaceous schist formation, produces the perfection of body, color, and ripeness characteristic of port wine. Besides this typical wine, Portugal produces a great variety of others, such as claret, the red, the white, and the sparkling. The average production of wines from Portugal is estimated to be 6,000,000 hectoliters, valued at $12,000,000. Port wine is drunk the world over, wherever a connoisseur of wine is found. Great Britain takes about half the amount exported annually, to be distributed to the world from the celebrated London docks. Brazil and Germany come next. The United States takes only 3,200 hectoliters, valued at about $100,000 of direct importation.

The fine exhibit at the Fair, however, and the energetic and tactful manner in which Senhor J. M. do Outeiro Ribeiro, the commissioner from Portugal, and at the same time the secretary for the jury of the wine classes, has presented the produce of his country will, without doubt, insure a very large increase of trade between the two countries.

Portugal's viticultural exhibit at the World's Columbian Exposition deserves the highest praise for the uniformly excellent samples of the different varieties of wines submitted to the jury. While different grades received different awards, there were really no inferior wines offered, which fact proves how carefully the Oporto Chamber of Commerce (Associação Commercial do Porto), who collected the exhibit, made their selection.

The Portuguese exhibit occupies about 1,650 square feet in the balcony of the southeast pavilion of the horticultural building. It is composed of about 10,000 bottles and 100 casks arranged in an artistically effective manner, about 70 exhibitors and 500 different varieties of wines being represented. The arches of the pavilion are intertwined with vines bearing bunches of grapes and draped with Portuguese and American flags, making a very attractive display.

Among other prizes, the following 11 houses are recommended by the jury as deserving the highest awards for "excellent" wines exhibited:

(1) Antonio Castano Rodriguez & Co., Oporto, for a complete collection of vintages from 1812 to 1890, comprising several styles of port wine.

(2) A. Rebello Valente Allen, Oporto, for his rich vintages of 1834 and 1847.

(3) Antonio Ferreira Meneres, Successors, Oporto, for the rich wines of 1847 and perfect old Muscatel of unknown age, and port wine above seventy years old.

(4) C. N. Kopke presented the excellent products of the famous "Quinta de Roriz" of 1834, 1847, and 1870, and others.

(5) Cockburn, Smithes & Co., carrying one of the largest stocks of wine in Oporto, whose products are well known in this country, being remarkable especially for their branches of "extra dry," "white," and "extra superior" and "special reserve."

(6) Companhia Geral da Agricultura das Vinhas do Alto Douro, Oporto, an old-established house of one hundred and fifty years' standing, well known in the foreign markets as the Royal Oporto Wine Company. They exhibit samples of vintages dating from the beginning of the present century.

(7) Francisco da Rocha Leao, notable vintages, 1815 to 1847.

(8) J. H. Andresen, Oporto, among other wines, the sample "Non Plus Ultra," an excellent type of rich old port wine, and the superior vintage of 1831, raised in the "Quinta das Lages," Upper Douro. This firm presented the best wine spirits exhibited, for which "excellent" was awarded too. It is the wine spirits used by his house for the blending of his wines.

(9) Miguel de Souza Guedes, proprietor of the "Quinta das Carvalhas," for samples of wines from this farm, vintages of the past ten years, and his old reserves 1830, bottled in 1854; his red wines of 1834, and others.

(10) Offley, Cramp & Forresters, for their typical collection of port, different vintages.

(11) Sandeman & Co., the well-known old house, for their samples carefully selected.

Besides the above collections of perfect wines exhibited by Portugal, several houses had special brands in their exhibit that were of the finest type. I may mention the Extra-secco 1882 of Visconde de Villarinho de St. Romão, which is excellent; he also exhibited other very good vintages. Warre & Co. had an excellent red wine marked "S. S." Wiese & Krohn had a long list of choice wines with a Coroa that was excellent. William & George Tait had a superior exhibit of several wines with a Nonpareil that was classed "excellent."

The beautiful wine exhibited made by Portugal was most complete, showing the different styles and grades in as compact a manner as possible.

WINES AND BRANDIES, MEXICO.

We regret very much not having been able to meet the commissioner for Mexico in order to obtain some information on the wines and brandies on exhibition in the horticultural palace, as well as on the peculiar processes of vinification and distillation in Mexico.

We examined the products of 19 wine exhibitors, some 30 samples in all, and we found it very difficult to give a general idea of these wines. Most of them showed, on the part of the vintner, an utter ignorance of the first principles of wine making and of the extra care wine in general requires.

THE WINES OF THE CAPE OF GOOD HOPE.

The culture of the vine in Cape Colony is very ancient, and probably dates from the arrival of the first settlers from Europe, that is to say, about 1652 to 1660. Some of the vineyards now in existence can be traced back to 1709 and 1713.

The first varieties of grapes that were imported came from France and from the banks of the Rhine. The former, more numerous, having been introduced by French Huguenots, who, expelled from France into Holland by the revocation of the Edict of Nantes, were drafted thence into the colony and allotted farms in the western provinces. As early as 1710 it was estimated that there were 2,729,300 vine stocks in the colony, producing 151,150 gallons of wine, a large proportion of which was shipped by the East Indian Company to its Indian settlements and even to Europe. The vineyards of the colony, occupying an area of 26,800 acres, produce 6,012,522 gallons of wine and 1,423,043 gallons of brandy annually.

Three different classes of wine are made, namely: (1) Sweet wines, under the general name of "Constancia;" (2) dry and semisweet wines of the sherry, Madeira, and port types; (3) light table wines, red and white. The sweet wines are commonly made from the Haanepoot, white and red Muscat, Frontignac, and Pontac (Teinturier). The wine known as "Sweet Pontac" is the product of the grape of that name with one of the Muscats used for flavoring. Most of the wines of the second category are produced by different manipulations of the Haanepoot and Muscadel, as the Muscat-Frontignac is also called there. The Grosse Syrah or Hermitage grape, the Pineau, and Cabernet are made into dry red wines which are not without a certain pleasant flavor and possess a beautiful color, but are rough, strong in alcohol, and lacking in freshness.

THE WINES OF AUSTRIA AND HUNGARY.

We were greatly surprised that Austria, which took so prominent a part in our great Columbian World's Fair, and whose exhibits in the different departments were second to none, contributed only a few samples to the viticultural exhibit. The abstention of Hungary was especially inexplicable, considering the great efforts that have been made of late years to introduce and popularize Hungarian wines in this country. That the agents of those Hungarian houses advertising extensively in our papers have not seized that opportunity of making their favorite brands known is, for us, a matter of speculation and regret.

At the Vienna Universal Exhibition of 1873 the Austro-Hungarian Empire was represented by 743 exhibitors of wines, contributing 3,363 samples. In Chicago there were only 6 exhibitors, contributing 12 samples.

A medal was awarded to L. Littke, of Vienna, for a collection of 3 brands of champagne, viz: Imperial Dry, Sport, and Dry Monopole, all with the qualities of a high-grade champagne. A Tyrolese red wine furnished by Francis Innerebner was found to be good, with clean taste and delicate aroma. The same exhibitor was also awarded a medal for his Tyroler Kräuter-Bitter, pronounced very fine and highly flavored. Two samples of Dalmation wine were found very poor, as were also two samples from Szegedin, Hungary. A To-kayer Ausbruch from Jos. Klein, of Budapest, although of no great style, secured a medal for its exhibitor.

THE WINES OF THE CAPE OF GOOD HOPE.

The vineyards of the Cape of Good Hope are said to date from the epoch of the Revocation of the Edict of Nantes, when some French Huguenots from southern France emigrated thither carrying with them some Muscat wines. There were only 4 exhibitors from Cape Colony at the Columbian World's Fair, and they contributed some 14 or 15 samples, most of which were sweet fortified wines.

J. Sedgwick & Co. were awarded a medal for a Constantia Frontignac, pronounced "excellent," and a good sweet Constantia Pontac. The former was a fine, luscious white Muscat, rather sweet, but of great character and refined flavor. The latter, a red Muscat, had not the refinement of the white Muscat, but its vinosity, not destroyed by the admixtion of a too large percentage of alcohol, together with its delicate flavor, made it very pleasant. The same house exhibited a Hermitage of no merit whatever. Another medal was awarded to J. H. Van Ryn for three different wines, namely: A fine white Frontignac, of great unctuosity, with rich, delicious Muscat flavor, a good grade of Lacrimæ Christi, and a Pontac a little too sweet and sirupy, but with light, delicate flavor.

E. K. Green, of Cape Town, was awarded two medals, one for very fine red Malmsey Constantia, and one for a sample of good light Sherry, which, although it had not exactly the character of a Jerez, was judged worthy of recognition.

Some other samples of sherry and port types, or so termed, had been too liberally fortified. A solitary sample of brandy was examined and found very poor.

WINES OF NEW SOUTH WALES.

It is a matter of regret that the wines of New South Wales exhibited at Chicago had suffered so much, some from having been frozen, all of them more or less from exposure to a temperature of 100° and over in that hothouse called Horticultural Hall. Over one-half of the samples submitted to the jury were out of condition, and in most

instances it could be seen that the wine was originally good, but had spoiled. Only such wines as had perfect corks, with bottles well filled, resisted the weather and remained sound. Not less than 245 samples of wine were examined, and, owing to the queer classification adopted by the administration of the Columbian World's Fair, to which we have already referred in one of our former reports, all fortified wines, sweet and dry, which did not go under the denomination of Sherry, Port, or Madeira were classed according to their color with either dry, white, or red wines, so that there could be found in the same class, 126, Sauternes, Hock, Verdeilho, Riesling, Chablis, together with Malaga, Muscatel, To-kay, etc., and in class 127, Claret, Burgundy, Hermitage, Cabernet, together with Muscatel, Frontignac, etc. The wines which oftener met with recognition were of the Hermitage type, but, owing to the heating process they had been submitted to during the whole summer, they had lost some of their freshness which they most assuredly possessed when first brought to Chicago.

Red wines of the Bordeaux type presented under the names of Claret, Cabernet, Malbec, Verdot, etc., were not as a rule of as high a grade as the Hermitages, being generally too thin for their alcoholic strength, and lacking "finesse" and bouquet. A few samples, however, were found with all the characteristics of high-class wines, and ranked first in the list of awards. Of the Rhine wine style—Hock and Riesling—the samples were numerous, but few of them showing remarkable features, only 8 out of 32 receiving some kind of recognition.

One of the grapes extensively grown in New South Wales is Verdeilho, the main variety cultivated in Madeira.

Some samples of Verdeilho wine purporting not to have been fortified, and ranging in alcoholic strength from 25 to 28 per cent of English proof spirit, were examined by the jury and found to be stout, heavy wines, lacking in vinosity, but with agreeable bouquet.

As a whole the New South Wales wine exhibit shows the great possibilities of that country for the production of good full-bodied wines, deficient in "finesse" and delicacy of flavor, although the lack of these qualities may be attributed to defectuous vinification or improper treatment of old wines.

Very few exhibitors had their wines properly bottled, bad corks predominating, and in most instances the wine barely reaching the neck of the bottle. Among the red dry wines awarded we deem the following worthy of special mention, viz: Four samples exhibited by Walter Y. Cousins, of Bebeah, namely: Malbec, 1881, a well-developed wine with full body, roundness, and fine flavor; Verdot, 1888, light, tender, and mellow, with great delicacy of bouquet—a pretty wine; Lambruscat, 1885, combining "finesse" and roundness; Hermitage, 1886, a rich wine of great mellowness.

From Henry J. Lindeman, of Sydney, Claret, 1889, a wine well developed, of full body, and pleasant bouquet. Your jury did not admire some semisweet Hermitage, Burgundy, and Cabernet produced by the same party.

Two samples from E. Wyndham, Bukkulla Vineyards, Inverell: Hermitage, 1874, and Burgundy, 1874, both remarkably well-preserved wines, of great character, but of a rather high alcoholic strength, which would lead one to believe that they have been fortified, a practice which our Australian friends should abandon for their dry table wines. On the other hand, we would advise them to have their sweet wines higher in alcohol, as most samples of the latter had spoiled by exposure, which should not occur with sweet wines of the types they aim at when of a sufficient alcoholic strength.

A good full-bodied Hermitage, vintage 1889, was exhibited by the trustees of the late J. Wyndham, of Dalwood Vineyard.

Of the different styles of white wines a few samples showed marked superiority over the others, and we will especially mention them here: A Chablis, 1880, exhibited by Bauffiers Brothers, of Sydney. A Verdeilho, 1891, of great body and mellowness, from Caldwell & Co., of Lake Albert Vineyard, Wagga Wagga. A White Hermitage, 1886, of high character, from James Kelman, Kirkton Vineyard, Branxton, Hunter River.

From J. Lindeman, two good samples of Hock, vintages 1884 and 1885, respectively, and a White Hermitage, 1883, rich and mellow.

Thomas Mather, of Roslyn, Inverel, presented a Shiraz, 1891, of remarkably clean taste and fresh flavor.

Two other samples of Shiraz from J. Wyndham were found to be light, vinous, and very pleasant.

As to wines of the Sherry, Port, and Madeira types, although some samples were deemed meritorious and worthy of awards, none showed any special distinction.

Before closing this report on the wines of New South Wales we desire to express our thanks to Mr. Pugh, the special commissioner in charge of the exhibit and our colleague in the wine jury, for his intelligent and effective collaboration, and we congratulate the New South Wales wine exhibitors upon having such an efficient agent to place their wines before the American public and international jury.

THE WINES AND BRANDIES OF TURKEY.

Owing to the list of Turkish wines prepared for entry being mislaid by the executive committee of awards, these wines were not examined before October, and as the bottles had been kept during the whole summer standing up on shelves in the Turkish pavilion, it is no wonder that few samples of dry wines were found in perfect condition. The exhibitors of wines and brandies numbered 22, with 30 samples of

wines and 13 of brandies. Awards were granted to 8 exhibitors of wines and 2 exhibitors of brandies.

Most of the red dry wines were heavy in color and alcohol, but, like those of Greece, thin in texture and lacking freshness. Among the best wines of that class, a Kétchi Mémessi (after the name of the grape) was found to be a good, full-bodied wine, very deep in color, of a type between a Burgundy and a natural Douro Port. A medal was awarded to its exhibitor, H. S. Soukiassian, of Constantinople, who presented also a rather pretty white wine called Misket Tchouch, dry, sound, and clean, and a Kara Tchouch, the product of red grapes not fermented on the husk, semisweet, light, and pleasant. The latter was recommended for award as "fair," but dropped by the executive committee on awards.

A dark red wine with good body and roundness, but containing a little excess of tannin, secured a medal for its exhibitor, Mr. J. A. Illidis, of Erdek. Another pretty wine, of the claret type, contributed by Mr. Selim Nasser, of Schtaura, Mount Lebanon, Syria, was pronounced good, sound, with good body, and a peculiar but fine flavor and bouquet, and medal given for same. The foothills of Mount Lebanon seem to be well adapted to the production of comparatively light wines. One of the largest, if not the largest, vineyard in Asia is to be found there, near the station of Schtaura. This vineyard is located about 3,000 feet above sea level, and overlooks the beautiful valley of the Beka, between Beyrouth, Damas, and Balbec, the celebrated Heliopolis. Messrs. Ibrahim and Selim Boulad, the proprietors of that vineyard, submitted to the jury samples of their different wines, consisting of white wines, dry and sweet, and of a red wine, claret type, of three vintages, 1889, 1891, and 1892. From lack of a proper storage and defectuous corking, all the red wines had spoiled. Your jury, especially interested in these wines, tried several bottles, and from those having suffered the least it could be seen that originally the wine was a good, medium, light Claret of bright color and good body. There was in it the stuff of a good wine, but we are inclined to believe that had the wine of the vintages 1889 and 1891 been strictly sound and fresh when bottled it would not have spoiled.

As Messrs. I. and S. Boulad contemplate enlarging their vineyard and the production of their French type of wines, they should improve their mode of vinification. They were awarded a medal for their white wines, dry and sweet; the former, a rather heavy, full-bodied wine of clean taste and flavor; the latter, quite distinct, reminds us of a Portuguese Verdelho, with peculiar, yet rather pleasant, aromatic flavor imparted to the wine by sweetening with honey.

The "Vin d'Or" (golden wine) of the Schtaura vineyard we found to possess a rank, disagreeable flavor, pleasant, no doubt, to the palate of the Levantines, as this wine is said to be in great demand in Syria and in Egypt.

The Muscat of Samos is considered the finest wine of this kind in the world, and its high reputation was sustained at the Columbian World's Fair by two samples exhibited by Mr. Athanase Tsoukaladaki and G. L. Mark, both of Samos. The wine from the former party was pronounced very fine, with high flavor and bouquet, although words but faintly express the qualities of that delicious wine, so sweet and unctuous and yet so light, with so high and yet so delicate and refined a flavor. The other sample was not quite of the same high grade, although fine and rich in flavor. Both were awarded.

Among other Turkish wines which, in the opinion of the jury, deserved recognition, we will mention an old sweet Muscat sent by the city of Kirk Killisseh and another wine, fifteen years old, having some resemblance to an old Madeira.

Most of the brandies exhibited were the product of inferior wines distilled with mastic and anise, and found to be unpalatable. Two samples of so-called "Cognac" were, however, judged worthy of awards: One, a new brandy of remarkably clean taste and nice flavor, from Mr. J. A. Illidis, of Erdek; the other, also a good clean brandy with the peculiar though pleasant flavor of the grape used in making the wine, contributed by Mr. Paul Gouttenoir, of Kirk Killisseh.

The jury had also recommended for award a sample of mastic and anise brandy of remarkably delicate flavor and showing a skillful distillation of good wine. We regret that, for reasons to us unknown, the name of the exhibitor, Nikolaki, of Samos, does not figure in the list of awards.

The quality of these three samples evidences the fact that sound wine and careful distillation can, in some parts of Turkey, produce a good grade of brandy. We doubt, however, whether people used to the permeating fragrance of the turpentine in their wines and brandies are able to appreciate the delicacy of flavor of a pure well-distilled brandy.

To summarize, if any opinion can be formed by the samples of wines and brandies submitted to the jury, it is that there are still among Turkish sweet wines some types worthy of their ancient fame, but in the vinification of dry wines, red and white, the wine men of that country have to adopt more improved methods, exercise more care, and give better attention to the keeping of old wines.

THE WINES AND BRANDIES OF GREECE.

We had anticipated the greatest delight in the tasting of the wines of Greece, so famous in remote antiquity. Were we not to find among them that luscious nectar, the juice of the golden grapes of the plain, sweetened with the ambrosial honey of Mount Hymettus, celebrated by all the poets of yore as the beverage of the gods?

Was it not from the beautiful islands of Greece—Tenedos, Lesbos,

Chio, Candia, Samos, etc.—that the barbarians of western Europe, later on, received their wines? Alas! how disenchanting was the plain, modern reality. We had forgotten that these are no more Greek, but Turkish, islands.

The isles of Greece, the isles of Greece!
Where burning Sappho loved and sung,
Where grew the arts of war and peace,
Where Delos rose, and Phœbus sprung!
Eternal summer gilds them yet,
But all except their sun is set.

* * * * *

In vain—in vain; strike other chords;
Fill high the cup with Samian wine!
Leave battles to the Turkish hordes,
And shed the blood of Scio's vine!

——BYRON.

Among the Greek wines exhibited only a few names suggestive of the glorious past—Aurora, Ambrosia, Nectar—and nothing, nothing but the names! Our modern Greeks, after having catered to the gods, are now catering to the growing taste of the public for light, dry wines, and the numerous labels of Hock, Medok, Margaux, even Château Lafitte and Château Margaux, showed the general tendency, in Greece as everywhere else, to an imitation of French and German wines.

The best collection of wines of the Bordeaux type was contributed by P. J. Skousès from his stock in the caves of the Grand Hotel, Paris, France. Two samples of his Clos-Marathon, of the vintages 1881 and 1885, respectively, were considered by the jury, very good, full bodied, rich in color and vinosity, but wanting a little in softness.

A red wine from L. A. Sypsamos, of Patras, was clean in taste, deep in color, and of good style, but slightly astringent. Of about the same character was a Bordeaux four years old presented by Nicolas Agyros, of Athens. All the above were awarded. We found most of the red wines harsh and rough, owing to an excess of tannin. Stemming and short period of fermentation on the husk would, no doubt, correct that defect.

Some white wines were of remarkable clean taste, light, fresh, and pleasant. Such was a sample of white wine, 1891, contributed by Zanos & Roche, of Athens, and another from Georges Pachys. This latter sample, styled "Tour la Reine," was of very delicate flavor and aroma.

Solon & Son, of Athens, exhibited under the names of Côtes Famèses some red and white wines, and also a "vin rosé," all clean and pleasant in taste and flavor.

Among the sweet wines awarded we will mention the following, viz: A Muscat of Patras, very fine and luscious, and a light, pleasant Muscatel, both from Theodoros Agapitos, of Patras; another sample

of old Muscat secured a medal for its exhibitors, Metaxa Brothers, of Pireus.

A few sweet wines of special character, namely, a Navrodaphne of delicious flavor from the Achaïa Society of Patras, some Phalerès wines, clean but distinct in taste, exhibited by Solon & Son, and a delicate red sweet Vissanto from Spyridion Denaxas, of Athens, complete the list of still wines worthy of mention.

Two brands of sparkling wines were awarded:

A sample from John Giorgiadis, of Tripolis, pronounced "excellent," had all the characteristics of a first-class French champagne—purity of taste, delicacy of flavor, and richness of texture.

The other samples, exhibited by Tapanicolaou, of Athens, was of an inferior grade to the above, wanting in refinement, but clean in taste and flavor, with good body without being too heavy.

Fifteen parties exhibited brandies or wine spirits, some distilled with mastic, others without. Hippocrates Kararias, of Athens, contributed a sample of brandy pronounced very good, with clean taste, fine bouquet, and pleasant flavor.

John Bollas, of Tripolis; Solon & Son, of Athens; Alexander S. Kouzès, of Athens; and Metaxa Brothers, of Pireus, contributed the other samples awarded.

THE WINES OF PERU.

Peru had only one exhibitor of wines, Mr. Adrain Ward, of Locumba, who sent five sorts of wines, styled Lagrina Seco, Lagrino Dulce, Vino Tinto Seco, Vino Tinto Dulce, and Vino Delicioso. Two of these were recommended for award, viz, the Lagrina Seco, a very dry Muscat of some merit, and the Vino Tinto Dulce, a dark red wine, sweet, and rather pleasant, but without much character. Owing, however, to the word "fair" being used by the member of the jury reporting on the former wine, the executive committee on awards dropped it from the list of awards. If the above were an average of the wines produced in Peru it must be confessed that the viticulture and the vinification of the country can be greatly improved.

THE WINES OF CHILE.

The wines of Chile were a surprise and a revelation to the three members of the jury who, one day, late in the afternoon, met in Superintendent De La Rue's office to examine these wines. If I am not mistaken, the samples passed on had been taken from the different exhibits, where the bottles had been standing up over five months, in the upper story of the building, which accounts for several originally good wines found to be out of condition.

The principal feature of the Chilean wines is their perfectly clean

taste. No "goût de terroir," no rough, heavy flavor of the grape, as often found in the valley wines of California.

They so closely resemble some Bordeaux wines that a Californian present at the sampling asked us whether we were sure that these wines did not come from France, for his opinion was they were French wines.

Most of the Chile wines were put up in nice style, with no pretentious names; in some instances the name of the grape the wine was made of, but oftener that of the manufacturer or his vineyard.

As a rule the Chile reds were of a higher type than the whites.

We would liked to have known the price at which these wines were selling at home, but we were unable to obtain any information whatever on this and other points of interest to the jury.

Two samples were pronounced "excellent," namely, "La Florida" brand, from Mr. Victorino Rojas M., of Santiago—a light, tender, delicious wine with fine, delicate bouquet; a "Santa Carolina Cabernet," from Mr. Louis Pereira, of Santiago—a robust, well-matured, smooth wine with a rich, refined Cabernet flavor.

Very close to these comes an "Errazury Panquehue Cabernet," from Gmo. Errazury, of Santiago—a very good full-bodied wine of great vinosity and roundness, with fine bouquet.

WINES AND BRANDIES OF CALIFORNIA.

By E. Dubois.

It is with some reluctance that I am undertaking to make a report on the wines of California; not for fear of criticism on the part of the malcontents, but because I am afraid I can not in this report, which must necessarily be succinct, do justice to all those who, among the grape growers of that favored State, deserve credit for their incessant efforts to raise the standard of California wines. The critics have been at work ever since and before your jury commenced its examination; on the system of awards first, on the jurors and their work next. Articles were sent to the newspapers of California in which the jury were represented as "unfriendly to California wines" and of "an aggressive sort"—condemning all of the white wines, with the exception of a few of them. Others complained that the awards were given too freely, and that Californians "when they got through the Fair" would have "a Christmas tree full of medals and diplomas." The perusal of this report will show that both informers of the California papers had very little information as to the number of awards given.

Owing to the late date the jurors were summoned to Chicago, the lack of a suitable place for the storage of the California wines, and also, to all appearances, as shown by the dryness of the cork, to the bottles having been kept standing too long, many samples were found out of condition, especially white wines and Burgundies. Even some sherries and ports were pricked, which could have been brought about only by a long exposure to the air, although it shows also that these wines were deficient in alcoholic strength.

Most of the Burgundies found to be unsound had fermented in the bottles, and so had a few clarets and Cabernets of the recent vintages, which is especially to be regretted, as, in general, sound samples of the youngest wines showed a marked improvement upon those of old vintages.

With the knowledge California wine makers have of the respective merits of the different grapes, it is a matter of surprise to your jury that many still persist in using a single grape in the manufacture of each wine, and presenting this wine to the public under the name of that particular grape. The Cabernet wine will generally have body,

vinosity, and bouquet, but lack that velvety softness of the Merlot wine. The latter will be deficient in body and roundness, and the Malbeck found wanting in body and bouquet. Now, by the mixture of these three varieties of grapes a wine could be produced combining fullness of body, softness, and delicacy of bouquet. The same remarks apply to white wines. When a party grows Semillon and Sauvignon Vert, what is the reason for making two sorts of wine instead of one? We take, for example, Mr. F. W. Billings's Sauvignon Vert and Semillon wines, both awarded; the former as good, full-bodied wine, with pleasant flavor, the latter as good, light wine, with nice bouquet; both certainly meritorious wines, but one a little too heavy, while the other is wanting in body. The mixture of the two grapes would have corrected the defect of each, and resulted in a perfect wine.

The exhibitors of California wines and brandies who entered their wines for competition numbered 53, and the samples submitted to the jury 348, divided as follows between the different classes, viz: Class 126, white wines, 127; class 127, red wines, clarets, Zinfandel, Burgundies, 93. For want of a better classification, all strong wines, dry and sweet, such as Malaga, Tokay, Muscat, Angelica, etc., were included in class 128 with sherries, Madeira, port, and with the latter numbered 108.

By the way, we can't help remarking that the party who devised this queer classification of the wines of the world did not seem to have any idea that besides sherry, Madeira, and port, there are other types of wine produced in France, Italy, Greece, Turkey, Austria, Chile, Cape of Good Hope, California, and even Spain and Portugal, known as Tokay, Muscat, Marsala, Malaga, etc. We would also like to know why, after having comprised in class 127 red wines, clarets, and Burgundies, he thought of specifying Zinfandel. Is Zinfandel a more special grape than Barolo, Barbera, Mataro, and many others? These anomalies in the classification caused many wines to be entered in the wrong class, as we shall point out when reporting on these wines.

The 117 samples in class 126 were exhibited by 41 parties, and consisted of 37 Riesling and Hock, 9 of which were awarded; 10 Chablis and others of the white Burgundy type, with 5 awards; 42 of the sauterne type, with 14 awards, and 28 samples of different other kinds, with 7 awards; the total number of wines awarded in that class being 35, from 22 exhibitors.

As an examination of the list of awards will show, the best Riesling wines were exhibited by Jacob Schram, of St. Helena; H. W. Crabb, of Oakville, and C. Carpy & Co., of San Francisco; the best wine of the sauterne type by C. A. Wetmore, of Livermore; C. P. Howes, of Mountain View; J. Crellin & Son, of Livermore, and C. Carpy & Co.; the best Chablis by H. W. Crabb.

In class 127 the 93 samples were entered by 49 exhibitors, and comprised 43 clarets and Bordeaux types of different denominations. Here the name is very little indication of the nature of the wine, for while some houses present their best blend of Bordeaux grapes as claret, the claret of other houses is their cheapest brand, being quoted even lower than Zinfandel.

Be it as it may, 34 samples out of 43 were deemed worthy of awards, and this proportion shows the degree of perfection already attained in the production of red table wines in California. Among the choice samples exhibited, the following wines received the most favorable mention: Haraszthy, Chateau d'Orleans, Chateau Gundlach, Wetmore's Margaux Souvenir, and the Cupertino Wine Company's collection of clarets of different vintages from the finest Bordeaux grapes, the vintage of 1892 being of especially high character.

As to Burgundies, they were rather disappointing; many samples had spoiled, others had not the slightest similarity to any of the wines known by that name, and only 7 out of 32 were found deserving recognition. A superb wine of great body roundness, and flavor, labeled Chambertin, was exhibited by J. Gundlach & Co., of San Francisco, while H. W. Crabb presented a remarkable wine of the Hermitage type, with good firmness and softness combined, together with a most delicate purity of aroma; also a robust, full-bodied, round wine of the Burgundy type.

Seventeen samples of Zinfandel carried 7 awards, and while none was of a very high grade, a sample from J. P. Smith, of Livermore, showed great body and finesse.

Among the 11 samples of other different types of wines, 3 were awarded, the most eulogistic mention being for two samples from the Italian-Swiss colony, namely, a Barbera of great finesse, body, and mellowness, and a Tipo Chianti of remarkable vinosity and roundness. To sum up, out of 93 samples in class 127, 51, contributed by 29 exhibitors, were awarded.

In class 128, 108 samples were examined and 41 reported for awards, viz, 7 out of 14 samples of Angelica, 11 out of 25 samples of Sherry, 10 out of 28 samples of Port, 1 out of 6 samples of Madeira, 3 out of 4 samples of Malaga, 5 out of 19 samples of Muscat, 3 out of 8 samples of Tokay, and 1 out of 4 samples of other wines. Most prominent in that class were the following wines: An excellent old Port and a fine old Sherry from L. J. Rose & Co., San Gabriel; a very good old Port and a very fine old Muscat from the Eisen Vineyard Company, of Fresno, and also a fine old Port from Stern & Sons, of Los Angeles.

In class 129, sparkling wines, 6 samples were entered by 3 exhibitors, two of whom were awarded for 5 of these samples, Haraszthy Brut being found of surprising clean taste, great delicacy of flavor, and pronounced excellent.

For brandies, class 131, the number of exhibitors who entered their products for competition was 24, some with several samples of different vintages.

The grade of California brandy is steadily improving, and a vast field is open before the distillers of that State. They must, however, bear in mind that it is only by the purity of their article and the discriminate use of the right sort of wines for distillation that they can overcome the prejudice attached to all our domestic products and have their pure, well-distilled and well-matured brandies take the place in our market of those aromatized spirits, blends, branded with the names of fictitious houses, and sold under the fallacious appellation of Cognac. Let our California brandy merchants drive all of these bogus houses out of the market of England and Australia, which are the largest brandy markets in the world. Some of the samples submitted to the examination of the jury showed remarkably clean taste, and delicacy of bouquet without the least earthy taste. Others were of a more stout character with less refined flavor, but having acquired great ripeness and mellowness from age, which renders them very acceptable and worthy of being called good, old brandies. A fine collection of different vintages was presented by Geo. West & Son, of Stockton.

After having read this report and perused the list of awards, our California friends will be convinced that the jury was neither aggressive nor unfriendly, and that, if the Christmas tree does not break down under the load of medals and diplomas, all wines and brandies deserving of praise received recognition at our hands.

WINES AND BRANDIES OF THE EASTERN STATES AND CANADA.

With the exception of California wines, which have been the subject of a separate report, the wines of the United States and Canada are made from native American grapes or their hybrids, and possess, like those grapes, distinctive characteristics which render comparison with the other wines of the world rather difficult, if not impossible. These characteristics are: (1) A peculiar flavor, more or less pronounced in all varieties excepting grapes of the Æstivalis class, such as Norton, Cynthiana, Herbemont, etc., a flavor which in the wine is pleasant to but a few Americans, and obnoxious to others, and generally to all regular wine drinkers of this and other countries; (2) an excess of acids, and in many cases a deficiency of saccharine matter, which makes these grapes unfit for wine making without an addition of water and sugar. This does not apply to the above-named varieties and other Æstivalis, which ought to really be considered as the only American wine grapes. Unfortunately most Æstivalis being late grapes, do not ripen well in the Northern States, and in the South they are subject to diseases.

Having to labor under such and many other difficulties—not being benefited by the provisions of the "sweet-wine bill," for example—our Eastern wine makers deserve great credit for the result they have already obtained, and it is especially so in the production of their sparkling wines, which are, as a rule, of a higher character than their still wines. Three brands of these sparkling wines (Champagne) having been pronounced excellent, I think I must explain the significance of the different terms used by the judges in reporting singly on each sample of wine.

Having to pass on wines of so diversified a nature and origin and determine the specific point of excellence or advancement of each wine, the task of the judges was not an easy one. It often happens that a wine has not anything striking in its quality, but possesses in a normal proportion the intrinsic features of a good wine. In that case the single word "good" was inserted in the report. If the wine was short of one, or deficient in some of these requirements, but still above the average of that class of wine, the word "fair" was used. In the class of wines which by their nature have to be judged more or less by certain accepted standards of foreign wines the characteristics of each sample were mentioned.

In order to do every one justice, the wines of each country had to be, however, judged from a different standpoint, taking into consideration the difficulties the wine makers have to contend with, the taste of the country where the wines are produced, and of the usual consumers of these wines, their commercial value at hand and abroad, and their advancement as compared with those formerly produced in the same country. It would not have been fair, for instance, to take as standards the greatest wines of the Old World, Chateau Lafite for claret, Romane Conte or Chambertin for Burgundy, the best brands of French champagne for sparkling wines, Schloss Johannesburger for Riesling, etc., all of which are the result of centuries of experience and study. It takes a man's life to study closely the different evolutions of a wine's life.

Although the vintner of a new wine-producing country has theories based on the Old World's practice, it is not sufficient. He has to learn by practicing himself, and if it is so for the countries who follow in the Old World's tracks and deal with the same kind of grapes, how much more so is it for the eastern American vintner who has no past to study from and imperfect material to operate on? It should not, therefore, be inferred from the fact that three eastern brands of sparkling wine have been pronounced "excellent" that these wines are necessarily of same high grade, of same commercial value, of same accepted type as an "excellent" French champagne, such as two French samples passed on have shown. Your jury simply deemed that, in their line and everything considered, these three wines were fine and as meritorious as the two French wines referred to.

Were we to advise our eastern wine makers it would be to not attempt making so many kinds of wines. How can they expect to make in Ohio and New York State a good sherry or a good Madeira when California, with the same grapes as raised at Jerez and Madeira and an almost identical climate, can hardly turn out an acceptable imitation of these wines? Why not confine themselves to a few types of good wines, dry and sweet, and do away with that long string of names which mean nothing when one comes to sample the wines, as most often the difference is only in the name and a few ounces of sugar, more or less, per gallon?

Eight States in the Union, viz, New York, Ohio, Missouri, Virgina, New Jersey, North Carolina, Florida, New Mexico, and the District of Columbia, contributed, together with the Province of Ontario, Canada, 274 samples for the examination of the jury. Not less than 48 different kinds of wines were represented—some with pretty names indeed—more than Spain with its 1,400 exhibitors. Fifty-five awards were given, including 65 samples, and were distributed between the different States, the District of Columbia, and Canada, as follows: New York, 134 samples examined, 36 awards to 20 exhibitors for 42 samples; Ohio, 41 samples, 8 awards to 6 exhibitors foi 10 samples; Missouri, 16 samples, 4 awards to 3 exhibitors for 6 samples; Virginia, 3 samples, 1 award to 1 exhibitor for 2 samples; North Carolina, 26 samples, 2 awards to 2 exhibitors for 2 samples; New Mexico, 3 samples, 1 award to 1 exhibitor for 1 sample; Canada, 21 samples, 2 awards to 2 exhibitors for 2 samples; Florida, 11 samples of "hors concours" (not competing) exhibited by one of the judges (the undersigned); New Jersey, 17 samples, no awards; District of Columbia, 2 samples, no awards.

The three brands of champagne declared excellent are Cook's Imperial, Pleasant Valley Wine Company's Great Western, and Hommel's Sparkling Catawba.

Among still wines none was found of so remarkable a quality as to deserve special mention. Out of 10 samples of Norton and Cynthiana presented, 8 were awarded, most of them of a deep rich color but lacking a little in body.

The Catawba wines, dry and sweet, were not of high character, many of the former being too acid and thin, and the latter wanting in that distinctive flavor of the Catawba grape, which, if objectionable when too pronounced in a dry wine or a champagne, is the principal attribute of a perfect sweet Catawba.

One of the requirements of dry wines and champagnes is a clean taste, great purity, and extreme delicacy of flavor, while sweet wines must have a decided bouquet, whether Muscat, Tokay, Catawba, etc.

New York sent a very creditable exhibit of brandies, especially apple brandies, and the samples furnished by J. L. Sayer & Son, Chas. G. Wisner, of Warwick, and D. A. Shaffer, of Montgomery, were deserving of great praise.

LIVE STOCK.

ARAB HORSES.

BY

Rev. F. F. VIDAL.

ARAB HORSES.

By Rev. F. F. VIDAL.

The classes it was my duty to judge and report upon were, first, Class XXXIV, pure-bred Arab horses and mares; second, Class XXXV, Americo-Arab horses and mares. I was generally disappointed at the small number of exhibits compared with the number of entries in each of these classes. It was not to be expected that there could be a large number of pure-bred Arabian horses exhibited, but I had hoped that those who were possessors in the United States of some of these rare and valuable animals would, for the sake of their countrymen, have had the patriotism to send them to the World's Fair as an instruction to breeders. I am often asked, and have been several times in the stock pavilion, "Wherein consists the excellence and value of the Arab horse over others?" My answer is, In his blood, entirely apart from any comparison of size or outward conformation with other breeds. A scientific breeder of horses can no more afford to ignore the value of the Arab blood than can the farmer the value of fertilizers. Without the one the breeding stock will as surely deteriorate until it becomes worthless as will the farmer's crops without the other. Everything that is valued in any breed of horses owes it excellence to the amount of Arab blood infused into the strain. The reason of this absolute truth is that the true-bred Arabian is the only exisiting horse of absolutely pure and unadulterated blood; and of such excellence in itself that any type of horse that the exigencies of mankind may require can be produced from it by scientfic selection and inbreeding. If breeders would study the question, first, scientifically and, second, without prejudice, as a scientist endeavors to seek and find a cause for an effect, they would discover that their success or failure depends upon the amount of Arab blood infused into the stock at a remote or later period.

With regard to the Arabs that were brought before me to judge upon in the stock pavilion, I have to say that the evidence of their purity of blood satisfied me. They came from the stud of Arabs maintained by the King of Wurtemburg. This stud is one of the only two studs of absolutely pure Arabians on the Continent of Europe, the other being in Hungary. There are also three in England.

Now, having expressed my belief that these animals from the royal Wurtemburg stud are pure bred, I must also state that in my opinion, though they are beautiful animals, they are not altogether perfect specimens. They all, more or less, are defective in a point in which pure Arabs are generally superexcellent, namely, their shoulders. The pure Arabian has as a rule the most magnificently oblique and powerful shoulder. I have known frequently the rear point of the top of the scapula to rest 6 inches behind the elbow. In the case of these animals a plumb line would touch both points.

The young stallion showed little of the characteristics of the high-bred Arabian. His head was slightly coarse and short, and he had a generally mean appearance. No doubt this colt will improve vastly with age. It is characteristic of Arabs that their heads fine gradually until they are 6 years old.

Of the mares, the gray, Aga, has a great deal of the beauty of form and action belonging to the Arabian; her sole defect is the shoulder, which, as I have said before, is upright. Her head is good and well set on; the arch of the neck is curved, and she carries her tail well up. Her action is elastic and true. Her eye is large and prominent. She lacks the peculiar prominence of forehead, so much desired in Arabs, called the "jibbah," but altogether she is a handsome animal. The bay, Hasfoura, was shown in very poor condition. She is a handsome mare with a good head, though a flat forehead, eye large and prominent, head well set on to a finely arched neck, shoulders too upright, back too much dipped. Her tail is carried well, and her action is straight, true, and lively. Both these mares have excellent hocks, knees, legs, and feet. They each stand about 15 hands 1 inch.

The Americo-Arab was a distinctly good class.

The young stallions, Fez and Aldebaron, greatly took my fancy. Both these are by Abdul Hamid II, who was by General Grant's Arab, Leopard, out of an inbred Clay mare, the property of Mr. Randolph Huntington, who has done so much and so successfully in this country to plant Arab blood on Clay soil.

Fez, a 3-year-old golden sorrel with white markings, standing 15 hands, is a very beautiful colt. He has a fine, clean, Arab-like head, well set on to a light, beautifully arched neck, eye full and prominent, shoulders very oblique, fine and yet powerful; back short, barrel round, and finely coupled; loins powerful; tail set on high and well carried; quarters lengthy and flat; thighs very muscular; hocks of the very best, clean and well formed; legs flat and hard as steel; feet sound and good. This colt, in my opinion, will develop into a very fine saddle horse. It is rarely that a youngster is found so forward in muscular development as he is. In addition to the blood of the imported barb, Black Emperor, he is, with the remoter crosses of Arab blood in his Clay progenitors, largely inbred to Eastern blood,

AGA.

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ABDUL HAMID II, BY LEOPARD.

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LEOPARD.

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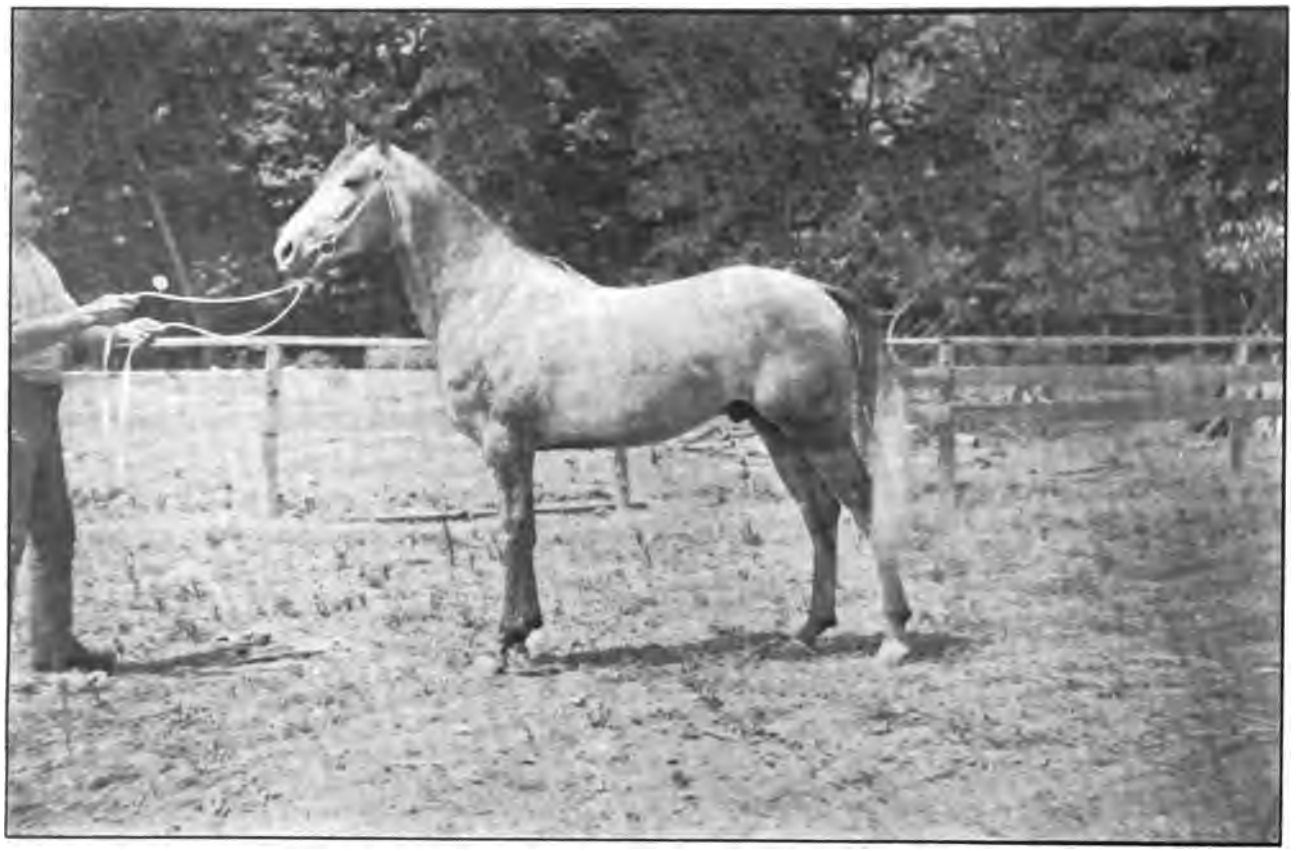


MIZZAH SHAFFEY.

UofM

and ought, in consequence, to be a very valuable stud horse. He was sired by the stallion, Mizpah Shaffey, bred by Heyl.

Aldebaron, by Abdul Hamid II, is a half-brother to Fez. He is a black colt, 3 years old, standing 14 hands 3 inches. He is a handsome colt, but with thicker head and neck than Fez; the same fine shoulders, back, and loins. The tail is set on slightly lower, but he carries it well. His joints and legs are equally good. He has fine trotting action, and I should imagine would make a fast trotter if trained. The grand dam of this colt was a Morgan mare, a fast trotter. He was bred by Dr. Hall, as was also Fez.

The mare, Keturah, is a dark chestnut with four white legs, 3 years old, and is by the same sire, Abdul Hamid II. She stands 15 hands 2 inches. This mare is good all over, and fit for either harness or saddle work. She is also of the breeding of Dr. Hall.

Of the others of this class, I should select two mares under a year old, Adelina and Marina, for special mention as being very beautiful and excellent in all ways, and a credit to their breeder. I do not know how they were bred, but was told they are a few generations from the Arab. Both are bays, showing great quality, substance, and power. I should be glad to see these youngsters when they have more years over their heads, and should be very much mistaken and disappointed if they are not then very exceptional animals.

I have said at the opening of this report that I regret a larger number did not appear in the ring, but enough were exhibited to demonstrate the excellence of an Arab cross.

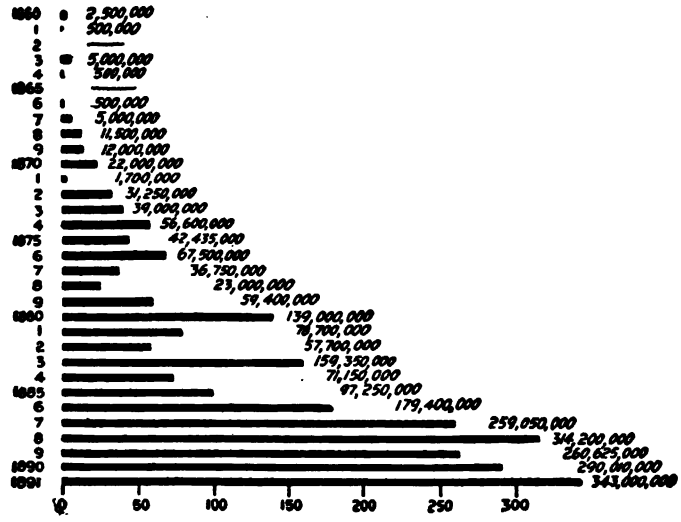
MACHINERY.

By R. H. THURSTON, *Judge.*

This exhibit is as remarkable for its novelty, its variety, and its usefulness as for its extent and costliness. It is unrivaled in its magnitude, is representative of one of the most important of all modern branches of steam-engine construction, and is of peculiar interest as illustrating progress made, during the generation just ended, in the improvement of a special class of machinery originally introduced by the founder of the house now making the exhibit and perfected by continuous experiment and constant observation of the conditions arising in the field of application by the inventor and his successors in the firm. All this machinery is of the same general and now standard type, and the immense extent and great variety of design here illustrated simply exhibits the extent and variety of application which has been demanded of the universally recognized Worthington engine. A careful study of this collection leads the engineer to the conclusion that it is as unique in its variety of design in adaptation to the various conditions under which water supply is demanded as in its ingenuity, neatness, and correctness of design and of proportions. The award asked for this collective exhibit on these grounds is, at best, but an inadequate recognition of the interest and value of the exhibit and of its preeminent usefulness to the great Exposition, to the success of which its continuous and always efficient operation and its economy of performance have in such large degree contributed. I have for many years been familiar with the products of this house, and knew the founder and his inventions when he was engaged in the work of slowly and painfully introducing the Worthington pump in its crudest form into the market. It was the first of the independent steam pumps (1840) and for years occupied the field without any real competition. The invention of the Worthington duplex pump and the introduction by others of steam pumps having auxiliary valves insuring the automatic movement of the main distributing valve of the pump led to the general use of this class of machinery, and it promptly—between 1860 and 1870—assumed a prominent place among the essential accessories of the steam engine and became as promptly an important article of manufacture. It is now almost exactly a half century since Henry R. Worthington, since deceased, invented the original type of this

machine. To-day the firm making this exhibit report a total output of over 70,000 pumps of all sizes and forms; while, the original patents having long since expired, the manufacture of the Worthington duplex pump by other makers has also come to be an enormously extensive and important branch of industry, both in this country and in Europe. The Worthington pumping engine, the latest development and outgrowth of the direct-acting steam pump, is now constructed for the water supply of cities in every part of the world, and New York and London, Chicago and Brooklyn, Montreal and the City of Mexico, the great cities of South America, of France, Germany, Austria, and Australia are supplied with the latest types of this machine.[a]

The accompanying graphic scale exhibits the growth of this business, showing the total capacity of the engines built each year, from 1860, in gallons:



The number of Worthington pumping engines reported by the makers to be installed in waterworks stations throughout the world is as follows: America, 957; Europe, 124; Asia, 44; Africa, 13; Australia, 9.

These exhibitors claim, and undoubtedly correctly, that theirs is the largest and most varied collection of steam-pumping machinery ever brought together at any international exposition. These engines have been continuously in operation, and have supplied all the water used for other than potable purposes within the limits of the Exposition. I have had frequent occasion to observe their condition and operation

[a] It has been estimated that not less than 60 per cent of the entire water supply of the Metropolitan district can be furnished by the Worthington engines at present installed.

WORTHINGTON PUMPING MACHINERY IS EXHIBITED AT PLACES MARKED BY FLAGS.

and to note their constant availability for the work demanded of them. They are distributed about the Exposition, as shown on the accompanying map supplied by the makers, but the largest and most interesting installation is in machinery hall and adjacent thereto.

The one distinguishing characteristic of this class of pumps and pumping engines is the operation of the valve of the one of a pair of twin engines by the piston motion of the other. In all pumps which are unprovided with the expensive and power-wasting accessories of fly wheel, shaft, and connections, the actuation of the valve must oe secured by some other automatic system of driving gear than the familiar eccentric and rod. Were it attempted to rely, as did the makers of the first of this class of pumps, upon the motion of the machine itself for the movement of its own distributing steam valve, either the valve would fail to open to its full and necessary area of port, even if continuing its motion at all, or the speed of pump needed to insure this effect through the action of inertia would be unsatisfactory. In the single-cylinder pump of the direct-acting class the valve and pump piston must constitute one piece, and they must have a common motion. For this reason it has come to be admitted that the only way in which the steam distribution can be made correct and certain in these pumps is by the provision of an independent valve system, the office of which is to move the valve of the main system. The operation in all such pumps is the same in principle and nearly identical in method. The motion of the pump, as it approaches the end of its stroke, moves the secondary or auxiliary valve and gives steam to a piston which in turn moves the main steam valve. This movement being effected the latter gives steam to the main piston and the pump stroke is reversed, the same succession of movements of the independent pistons taking place on the return of the main piston to the opposite end of its cylinder. It is easily seen that since the two pistons are independent the motion of either must continue, once started, until it has made its stroke, irrespective of the movement or stopping of the other. The process is thus: (1) The opening of the main piston to steam, through the operation, automatically or by hand, of the main valve; (2) the traversing of the cylinder by this main piston, producing a working stroke of the pump; (3) the shifting of the valve of the auxiliary steam piston in such manner as to throw it across its own cylinder, carrying over, at the same time, the main steam valve to which the auxiliary piston is secured; (4) the reversal of motion of the main piston and the performance of another working stroke of the pump in the course of its return to its starting point. The cycle is then repeated and continued indefinitely, or until steam is shut off from the machine.

The duplex pump of Worthington is one in which two steam pumps are placed side by side, and each is the auxiliary system to the other.

The auxiliary piston of the older type becomes here a working piston as well. The twin pumps make their strokes alternately, each, at the end of its own stroke, giving motion to the steam-valve system of the other, and itself halting while the second makes a stroke, and, at its termination, acts as starting engine for its fellow. All modern forms of Worthington pump embody this feature, and are duplex pumps, the type having been original with the founder of this house. It is by the adoption of this device that the most certain operation, the smoothest movement, and the most perfect regulation and adjustment to the prescribed work are secured; while, as a direct-acting system, the elimination of the fly wheel and its accessories gives the advantages of decreased complication and cost, lessened weight, and reduced volume and cost of foundations, as well as of the machine itself. In cases in which the price of the fuel is so low as to make the interest account on first cost a relatively important matter—as is often the fact in locations not far from good coal deposits—this cheapening of the cost of engine, foundations, and erection may prove more important than slight differences of engine efficiencies. Where efficiencies are approximately the same, this difference of cost gives the vender an advantage which he usually shares with his customer, and the fact gives him a market otherwise beyond reach. The finance of steam-engine economy has, of late years, assumed great importance, and the interest account and other permanent taxes are carefully considered, as well as the regular operating expenses on account of labor and fuel. Such considerations often settle an otherwise doubtful choice among the various forms of engines available for a specified purpose.

The collective exhibit of H. R. Worthington includes illustrations of the principal types of direct-acting pumping engine now built for the market, and some which possess points of peculiar interest and novelty. Those installed in the large Worthington pumping station are one 25 and 50 by 27½ by 36 horizontal high-duty pumping engine, with attached condenser, with a capacity of 12,500,000 gallons in twenty-four hours, working against a pressure of 100 pounds with 125 pounds of steam. Also one 30 and 60 by 32 by 60 vertical compound condensing engine, with independent condenser, of 15,000,000 gallons in twenty-four hours, working under the same conditions. Also one 15 and 33 and 57½ by 22 by 36 vertical beam-compound condensing engine, with independent condenser, of 7,500,000 gallons capacity in twenty-four hours; and one 9½ and 15 and 25 by 11 by 48 horizontal high-speed triple engine, with independent condenser, of 5,000,000 gallons capacity in twenty-four hours, working on the same service. In the same building there are two Worthington underwriter fire pumps for fire service. In machinery hall, Section A, there are in operation seven pumps, handling water for circulating purposes, with a combined capacity of 24,000,000 gallons in twenty-four hours,

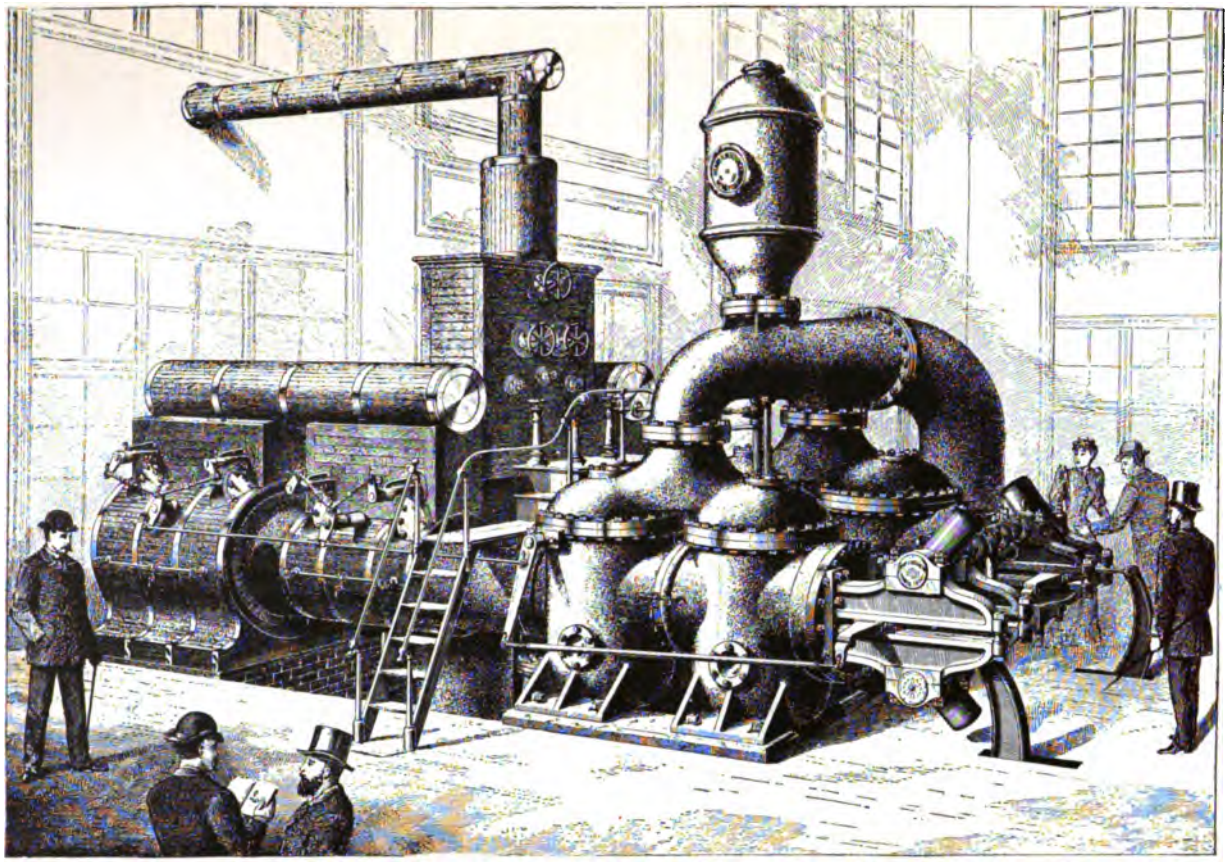
divided as follows: One 16 and 25 by 15 by 15 compound pump, capacity two and a half million; one 18½ and 29 by 17 by 18 compound pump, with a capacity of 3,500,000 gallons in twenty-four hours; one 12 by 14 by 10 pump of 2,000,000 gallons capacity; one 14 by 19 by 15, 3,500,000 gallons capacity; one 14 by 22 by 15, 4,500,000 gallons; one 29 by 20 by 18, of 4,000,000 gallons capacity, and one 14 and 24 by 20 by 18 compound condensing pump, with independent condenser, of 4,000,000 gallons capacity. In this location is also an exhibit of thirty-four pumps of various sizes designed for special services, but not in operation.

Distributed at different points throughout the Exposition grounds are about twenty Worthington pumps, most of which are in operation. In the greenhouses attached to the horticultural building are three pumps and receivers operating in connection with the heating system. In the power house of the Western Railway is a 12 by 15 by 10 Worthington independent condenser, condensing steam from their engines. In the Libbey glass factory is a 7½ by 4½ by 6 pump, feeding their boilers. In the exhibit of the Norwalk Iron Works in machinery hall is a 12 by 15 by 15 Worthington condenser operating in connection with their engines. In the transportation building are two 16 by 25 by 15 by 15 compound Worthington pumps, operating Otis elevators. In the annex to machinery hall is an 18½ by 5 by 10 pressure pump, operating Crane elevators. In the power plant of machinery hall are two 14 by 19 by 15 independent condensers operating with Westinghouse engines. In the United States battle ship *Illinois* is a 10 by 7 by 10 Admiralty pump. In the United States steam launch is a 2 by 1⅛ by 2¾ pump, feeding boilers. In the exhibit of the United States Wind Engine Company is a 10 by 6 by 10 Worthington pump. In the electricity building is a 7 by 10½ electric power pump in connection with the Westinghouse exhibit. In the transportation building is a 9 by 2½ by 10 Worthington pressure pump and steam accumulator in connection with the Otis exhibit. In machinery hall is a 12 by 15 by 10 condenser, operating in connection with the Ball engine. In the boiler house of machinery hall is a 6 by 4 by 6 Admiralty pump and a 7½ by 4½ by 10 pressure pump, feeding a battery of Zell boilers. There are also Worthington pumps in the sewage department.

This extensive, costly, and interesting exhibit contains illustrations of two principal classes of Worthington duplex pumping engines, both of which embody the twin system above described, and are distinctively Worthington pumps, but differ in the fact that the latest examples of the machine, constituting the more modern class, are fitted with what is known as a "high-duty attachment," through the action of which the engine is made very much more economical than the older type. Since these engines are direct acting, and since no practicable method of employing steam expansively has been devised

which will make the total steam pressure on the piston a constant quantity and equal to the hydraulic resistance of the load, there must, in all pumps of the older form, exist a variable driving effort and a substantially invariable load on the pump plunger or piston. It is thus only practicable to expand the working steam down to such a point as will still leave sufficient forward pressure at the end of the stroke to complete the stroke of the piston against the resistance of load, back pressure, and friction combined. This fact restricts the range of expansion in even the multiple-cylinder engine of this class to a comparatively narrow range, and some device which shall equalize the difference between the driving and the resisting forces, acting upon the passing stream only, can give the power of continuing the expansion of the steam to the extent which is now known to be essential to economical working. None of these engines have, in their older form, given duties which would to-day be regarded as high, and their use has thus been restricted to cases in which their comparatively small cost of construction has compensated anticipated differences in economical performance as compared with rival constructions. A duty of 75,000,000 foot-pounds per pound of good fuel is a high figure for the older duplex engine, even when compounded. Duties exceeding 100,000,000, and often approximating 120,000,000, or even more, are now expected in the best modern practice as representative of what is considered high economy. The second class of engines of this kind, as exhibited in this section, are expected to approach such figures as these last. They are fitted with an equalizing apparatus which, by alternate storage and return of energy, reenforces the deficient pressure of the expanded steam, while at the beginning of the stroke it resists the overplus of pressure, producing in this manner, throughout the stroke, a comparatively complete equalizing of the net working pressure and the load resistance, whatever the ratio of expansion adopted. This permits the use of high pressures and of correspondingly high ratios of expansion, and this in turn gives the thus improved engine an efficiency substantially equal, thermodynamically, to that of the best type of crank-and-fly-wheel engine.

The high-duty Worthington pumping engine, illustrated in the accompanying figure, is of this latest standard construction. Its compensating cylinders are seen at the nearer end of the structure and outside the pumps. They may be placed at any point in the line of the piston and pump rods that may be found convenient. They consist simply of a pair of plungers working in oscillating cylinders of suitable size, so placed as to precisely counterbalance each other in all lateral efforts, while giving a resistance to the motion of the engine and pump at the commencement of a working stroke, this resistance falling to zero at the half stroke, and becoming a reenforcing effort, during the second half stroke, of continually increasing



THE WORTHINGTON HIGH-DUTY PUMPING ENGINE.
Built for the World's Columbian Exposition, Chicago, 1893.

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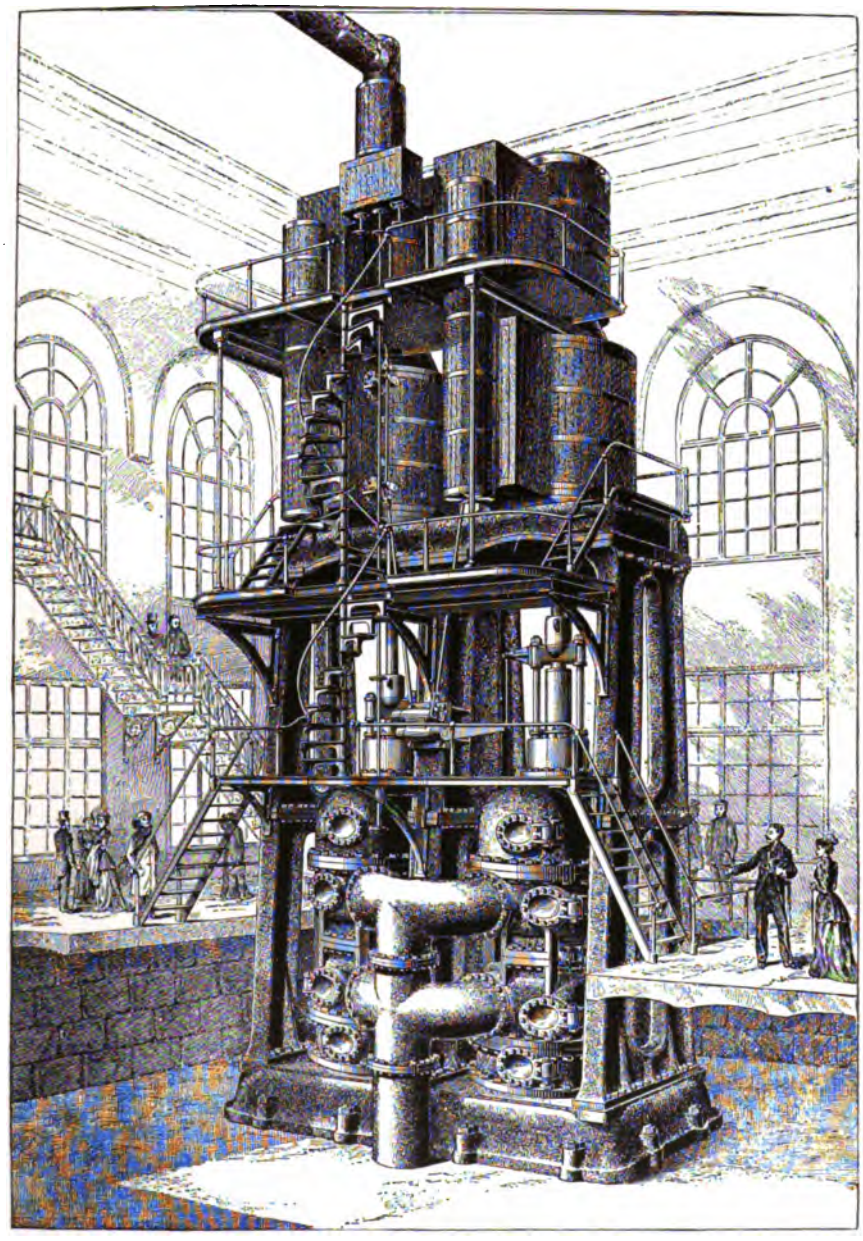

THE WORTHINGTON VERTICAL PUMPING ENGINE.
Built for the World's Columbian Exposition, Chicago, 1893.

Non

magnitude. It is found perfectly practicable, with the best proportions of engine, and with the most desirable ratios of expansion, to so proportion these compensating cylinders as to secure practically complete equalization of the net driving force of the expanding steam, which, in these engines, expands from a pressure far in excess of the resistance of the pump down to a pressure as far below that required to keep up the motion of the piston and the flow of the water, the compensating device supplying resistance during the first phase and the needed additional effort during the second phase of piston movement. This wonderfully simple and effective device has converted a comparatively uneconomical steam pumping engine into a machine of the highest possibilities in thermodynamic and mechanical efficiency. The abolition of the fly wheel, while retaining the power of employing steam expansively, constitutes an improvement upon the older type which originated with Watt and his successors of the early half of the century that must be rated as of the highest order, and as the more meritorious for its supreme simplicity. Watt sought in vain for a practically effective device of this character. What Watt and his contemporaries and successors failed to accomplish has been done by Mr. Charles C. Worthington, the son and successor of the distinguished founder of this firm (1884). The device here illustrated costs little, adds no perceptible resistance to the load, is simple, unlikely to get out of order, and adds 50 per cent or more to the value of the engine as measured by its economical performance. It is at once the simplest and the most important of all the improvements effected in the construction of direct-acting pumping engines by these makers and is to be classed among the great inventions of the time.

The exhibit here reported upon contains examples, also, of another interesting and valuable departure from hitherto usual practice—the vertical type of duplex engine, without fly wheel. Of this novel type there are two illustrations, both of large capacity, and doing work, as occasion arises, in supplying water for use in the Exposition, to the extent of 37,500,000 gallons in twenty-four hours, the one having a capacity of twelve and a half, the other of fifteen millions per day. The general appearance of one of these machines is exhibited in the accompanying figure, and it is seen that it gives a remarkably compact construction, economizing floor space greatly, and at the same time, is accessible in all parts for examination, lubrication, and repair. The side elevation of the machinery and section of the station, also illustrated herewith, give a good idea of the relative compactness of the two forms of machine, the horizontal and vertical.

Still another interesting and novel departure from common constructions of pumping machinery is found in the fourth of the engines erected in the pumping station with the preceding, a horizontal six-cylinder, triple-expansion engine, designed for an unusually high

speed of engine-piston and pump. The speed adopted is 350 feet a minute, double that customarily employed in earlier constructions of steam pumping engines. So well designed and constructed is this engine that it works at the designated speed with the utmost quietness and smoothness. While no one special feature is here to be noted as embodying a great invention or peculiarly ingenious adaptation of

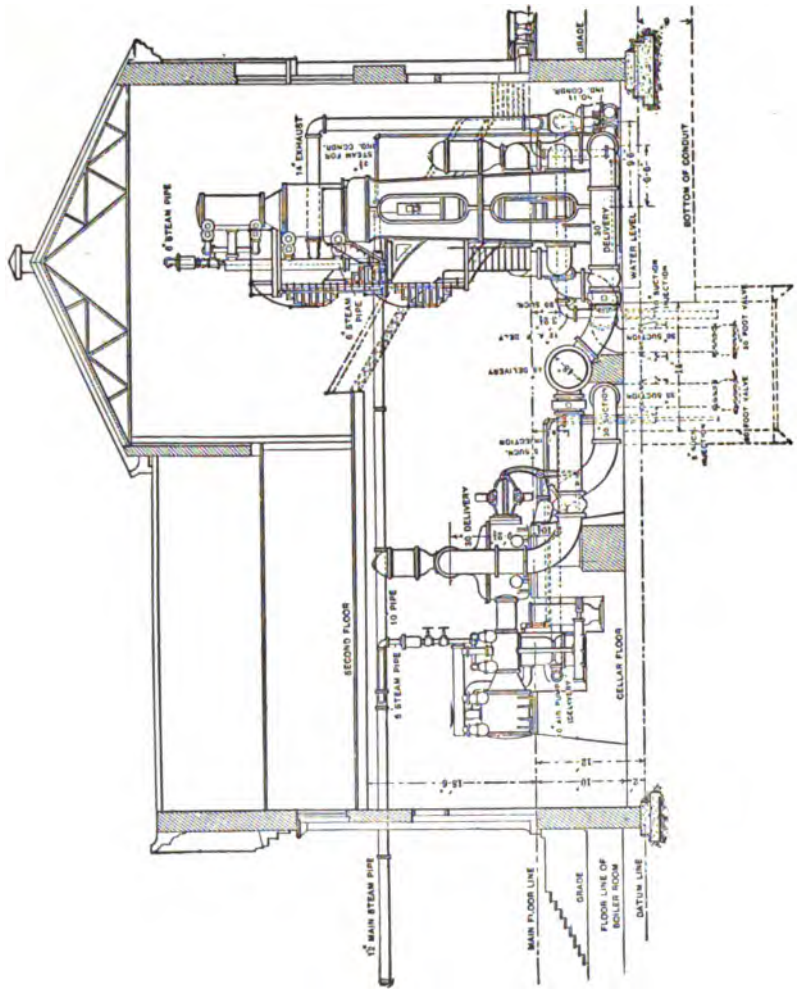

FIG. 5.—Side elevation of pumping station.

known devices to new purposes, the skill of designer and constructor is nevertheless illustrated in a remarkable manner by the excellence of proportions, the admirable workmanship, and the satisfactory performance of the machine. This is, so far as I am aware, the first successful attempt to arrange a triple-expansion engine for such work as is here performed.

Connected with the engines are examples of the Worthington construction of independent condenser and air pump, an accessory to the high-expansion steam engine, and to marine engines, which has of late years come to be considered as often of extreme importance. It permits the production of a good vacuum in advance of starting the engines, and thus enables them to be started off at full power at the desired instant—a peculiarly important matter with high ratios of expansion, and where the power is in very large proportion that obtained by the action of the vacuum. It is also useful in pumping engines, where the load is a maximun at the instant of starting.

In marine engines this independence of condensing system and the main engine permits the former to be operated at precisely the right speed, and at any time, whatever the speed of the main engine or its variations, in heavy seas or under other trying conditions. These condensers are also largely used in connection with stationary engines in mills and factories; their cheapness, compactness, and handiness giving them, frequently, the preference over the attached air-pump and condenser system formerly exclusively employed. Where the exhaust steam can be utilized for heating feed water or other valuable applications, they are not seriously uneconomical of steam; this point being their most objectionable departure from old standard practice, in which the cost of operation was measured by the economy of the main engine. The Worthington condenser and air pump, of the independent variety, embodies the advantageous qualities of the class, and possesses the disadvantageous attributes in better proportion than is usual, and they have therefore come into very extensive use and are to be found at the Exposition in operation in connection with the engines of a considerable number of exhibitors, as well as in that of H. R. Worthington. They constitute a valuable and interesting feature of these exhibits.

The four pumping engines above described, with their ingenious, valuable, and diverse forms of design, constitute, as a collection by themselves, one of the most attractive, impressive, and satisfactory exhibits to be found at the Exposition, and, in their class, are unique and unexampled, at any time or in any place.

The most striking and novel points of construction to be noted in these various forms of Worthington pumping engine may be stated in a very few words. Of one, the horizontal "high-duty engine" is the now standard pattern, and its peculiarities, and especially its provision for securing high expansion and consequent high duty, have been already fully described. The other three of the four large engines in this exhibit represent, each in its way, a somewhat novel and radical departure from the older designs.

The vertical engine is a very recent and exceptional variation from the old forms. A balance of working parts is secured by means of

beams, and it is thus rendered possible to obtain a Worthington engine with single-acting plunger pumps. In some situations this form of pump is considered essential, and outside packed plungers are absolutely demanded. It is necessary, in this case, to secure an equal division of work between the two sides of the machine, and this is effected, in this case—that of the large, vertical, triple-expansion pumping engine exhibited—by dividing the high-pressure cylinder, assigning one of the pair to each side. This gives the required regulation of the two machines, which act as one in this new type. It is stated by the makers that a duty of 130,000,000 foot-pounds per 1,000 pounds of steam used has been attained by this form of engine.

The other and larger vertical engine illustrates a singularly novel and effective method of balance of the load and a peculiar construction of the water end of the machine. The first of these results is attained by alternately compressing and expanding any gaseous fluid in a closed tank. It is simple, effective, and is not subject to accident or derangement of adjustment. It accomplishes its purpose thoroughly well and seems to have no important defect of design, construction, or operation. Any leakage is readily supplied from the pump main. In the construction of the pumps half the valves are inverted in this engine. The pump is thus made compact and the space occupied by the engine made remarkably small, even for this class of machine. The makers inform me that this plan has been in successful use in their engines for several years past, and has proved in every instance satisfactory. The valves are made very light and are supported by a spring of ample resilience. The plan permits more pumping capacity to be attained in a given size of well than with the older arrangement of pumps, and the builders refer to the Memphis waterworks, where they have three 10,000,000-gallon engines at work in a well 38 feet in diameter, and space still remains for another of similar size.

The fourth of these engines exhibited is mainly distinguished by its high speed of piston and by the arrangement of its triple-expansion system of twin engines, which, while necessarily making a long engine, occupying considerable floor space, is, nevertheless, so designed as to be very compact for a triple-expansion machine, and yet to give easy access to pistons and working parts.

The Worthington steam pumps are simply small direct-acting pumps of the duplex variety, and of the same general design with the simplest form of large pumping engine, none having a "high-duty attachment," although it is very possible that cases may arise in which this appendage might prove economically desirable, even on these small machines. There are 34 of these pumps distributed about the Exposition, the larger number by far being placed in machinery hall. Among them are 9 pumps having their steam cylinders compounded, similarly to

the older form of Worthington pumping engine. These are the largest pumps, having steam cylinders from 12 and 18 to 16 and 25 inches diameter, with 10 to 15 inches diameter of pump and of 10 to 24 inches stroke of piston. They are proportioned for all steam pressures and heights of lift, and adapted to every variety of application, from simple water elevation for house supply or for filling water tanks for railways, to use as fire pumps or in elevation of water from the deepest mines. In all cases they embody the Worthington principle of actuation of the valve motion of one engine by the piston movement of its twin, a pair of duplicate machines in all cases constituting a single pump. In this extraordinarily extensive collection, I note in addition to the 9 compounded machines: Five pressure pumps, 2 with packed plungers; 5 with packed pistons; 4 of the old, regular, standard pattern, above described; 1 dry vacuum; 2 large Underwriters' fire pumps, 16 and 19 inches diameter of steam and water cylinders, respectively; 3 Admiralty pumps; 1 each, sinking, brewery, ammonia, racking, and wet vacuum pumps; 4 boiler feed pumps; 2 air compressors; 3 pumps with receivers; a wrecking pump, 18 and 30 inch cylinders, 9 inches stroke, and various miscellaneous minor exhibits. In number, value, variety, and novelty this section of the Worthington exhibit is as remarkable in its way as is the imposing collection of great pumping engines, and the same verdict will here apply.

There are, altogether, 25 different varieties of pumps in this great collection, and between 80 and 90 individual exhibits, all illustrating the latest and highest state of the art of construction of their class of machinery.

The Worthington Water Meter is a long and well known example of that class of apparatus. It consists of a twin system of pumps, somewhat like the standard Worthington pumps of regular pattern, but with inverted operation; being driven by the flowing stream instead of compelling its flow. Its constant volume of displacement gives a measure of the volume of water thus passing through it, and the instrument, while in action, each element working by alternation with its fellow, measures off the quantity of fluid received and discharged; the total being automatically recorded on a dial, provided with suitable mechanism to take the motion from the two pistons of the meter. It is read like the common gas meter. These machines find extensive use wherever water has commercial value, and many large cities employ large numbers of them as a means of fairly taxing their citizens and householders for water consumed, either in manufacturing or for domestic purposes.

These meters are ingenious in design, of excellent material and workmanship, and under favorable conditions of operation extremely accurate; so exact, in fact, as to find use as instruments of scientific

and exact measurement in steam-boiler trials and other work of the engineer in which accuracy is required. I have frequently employed them in scientific work, and find that with proper care in standardizing and checking by the customary methods they make an extremely satisfactory and convenient means of measuring volumes of water and other fluids. Their extensive use in city water supply is the best and ample proof of their value for general use. The Worthington exhibit of meters is itself alone noteworthy, and in extent, variety, and excellence, as a whole and in detail, is most remarkable.

The design and construction of the individual items of the collective exhibit of H. R. Worthington have been made the subject of report by competent and distinguished judges, and it is only necessary here to state that they are in all respects admirable, and worthy alike of the great Exposition of which they constitute so important a part and of the famous firm which has shown so much enterprise in their selection and contribution. Each is well adapted in its general form and in all its details to the special purpose for which it is intended; each illustrates good judgment and good taste in form of proportions; each illustrates the use, in proper place and proportion, of the best of commercially available materials; and all, without exception, exhibit the best of workmanship, judged from a business point of view. Manufactured by piecework, and under rigid inspection and the adoption of a system of interchangeability as far as is in such work practicable, have rendered the construction of these machines at once satisfactorily perfect and singularly inexpensive. It is probably no exaggeration to say that it would cost twice as much to build them by the methods of a generation ago as it actually costs to-day. This enormous gain in economy necessarily, through the action of competitive supply shared between makers and the public, constitutes a gain which has real importance for the whole country. The manufacturer is, in such a case, a public benefactor. Our enormous material progress during the century, marvellous as it has been, has been due largely, probably principally, to the activity and the genius of our inventors and constructors of machinery. They have received comparatively slight recognition, but their deserts exceed those of any other class in the community. The awards proposed and conferred at the World's Columbian Exhibition for such displays as this collective exhibit, and the thousands of others less extensive, perhaps, but no less meritorious in many instances, are deserved but necessarily far from adequate recognition of the wonderful and beneficent work of the inventor and mechanic.

The economical performance of the machinery of this exhibit can not be gauged on the ground, but must be judged by the operation of similar machines as employed for similar purposes elsewhere. Fortu-

nately, there is no deficiency of data. Hundreds of the pumping engines built by this firm are in use, and under circumstances which permit, and often under contracts which compel, their accurate economic test. The total pumping capacity of the engines built to date by this firm, and of the types here represented, approximates 4,500,000,000 gallons in twenty-four hours, supplied by some 1,200 engines. Of these, large numbers have been subjected to duty trials, under contract or for the satisfaction of the builders or buyers, and of these trials many have been made with all the accuracy that modern science permits. The builders publish a book in which these latter are summarized, from which I glean the following brief collection of data.* They relate to the latest and highest type of the machine. They are all of later date than 1884, that of the first application effected by these makers of a cutoff to a direct-acting nonrotative engine, with success and resultant economy.

Mr. J. G. Mair, in a paper read before the British Institute of Civil Engineers, describing an examination and test trial of a small engine of this class, as made by him in 1885, the engine indicating between 108 and 130 horsepower, obtained a mechanical efficiency exceeding 90 per cent, and a duty on 112 pounds of coal assuming a mechanical efficiency of 88 per cent of 112 millions as a minimum, and 114.8 millions as a maximum, in the series of tests. The officials at a trial of a 5,000,000-gallon engine at New Bedford, in 1887, reported a duty of over 102,000,000 on 100 pounds of coal. Practically the same figure was reached in the official trial of a 10,000,000-gallon engine at Montreal in 1888. On the same basis, a duty of 121,795,222 foot-pounds was officially reported at Davenport, Iowa, for an engine of the smaller size, and the loss of mechanical efficiency was there reduced to the smallest figure yet recorded so far as known to me; the efficiency being given in this case as 96.3 per cent, the waste by friction thus being but 3.7 per cent. Professor Unwin, in 1888, reported to Messrs. Simpson & Co., the English agents and builders for H. R. Worthington, that the results of tests of a 200,000,000-gallon engine at Hampton, as made under his direction, indicated a duty of 106,513,000 foot-pounds per hundredweight of coal. The engine applied in useful work 0.8495 of the indicated power, the energy received at its pistons from the steam. A pair of engines of aggregate capacity of 30,000,000 gallons in twenty-four hours at Minneapolis, Minn., guaranteed to give a duty of 115,000,000 per 100 pounds of fuel, were reported by Professor Pike to have actually given a duty of 116,683,000 foot-pounds, with no allowances whatever. Numerous other and later tests confirm these reported figures. Mr. W. H. White reported the duty of the Worth-

*Duty and Capacity Tests of Worthington High-duty Engines on Waterworks and Pipe-line Services; Henry R. Worthington, New York, 1892.

ington engine at Oxford, England, to have been in 1891, 122,000,000 on ten pounds of water evaporated, and, on the British basis of weight of fuel, it gave 125,100,000. These results of actual test, and as given in official reports of indisputable reliability, are so remarkably creditable to the builders of this engine that no hesitation need be felt in reaffirming the statements of the judges in this case, and in seconding the recommendation that an award be given the collective exhibit of H. R. Worthington, for its extent, the excellence of design, the admirable construction, and especially the high efficiency of performance which these machines are proven to be capable of exhibiting.

MANGANESE FROM VIRGINIA.

BY

JOHN S. APPERSON.

MANGANESE FROM VIRGINIA.

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The mines of the Staleys Creek Manganese and Iron Company, from which this exhibit of manganese ore at the World's Fair was taken, are located in Smyth County, Va. The deposits are scattered over about 7,000 acres of land, and have been opened only by exploratory work. The manganese is here, as elsewhere, associated with iron ore, some of which is highly manganiferous, while in other places it is almost free of this admixture. The country is a broken region lying between the Middle and South Forks of Holston River, and nearly on the line of the Norfolk and Western Railroad. The manganese is found mainly in the foothills, below the manganiferous sands and clays lying near the top of the ridges. On the north side of Pond Mountain a deposit underlying a heavy ledge of compact brown hematite ore may be seen. This deposit resembles what is described as wad, and is some 8 feet in thickness, and quite hard. Analysis by Ledoux & Co., of New York, 1890, gives manganese 62.71 per cent, with only a trace of iron. On the north side of Rich Mountain, near Dean's Branch, on the side of a steep ravine, are several openings from which some 5 or 6 carloads have been taken. Here the ore in two forms (pyrolusite and psilomelane) is found outcropping near the surface, while below it is embedded in a gangue of earth and loam; deeper still it is held by a soft sandstone containing a small per cent of lime. Now and then there is a stratum, or it may be an irregular-shaped mass, of a tough clay, white in appearance or flecked with small particles of manganese. The ore near the surface is in lumps varying in size from that of a pea to irregular-shaped bowlders of several hundred pounds in weight. Where it is found in the sandstone formation below it is in some places distinctly stratified or in sheets of variable thickness and length. This arrangement is distinctly shown in the face of a cut some 20 feet in height. The waste heap here shows a large percentage of wash manganese which has not been separated and utilized. From this mine 2 carloads were taken in 1892 and shipped to Carnegie Brothers and gave the following analysis:

Iron	1.969– 4.646	Moisture	1.000–1.000
Phosphorus	.243– 2.28	Silica	Not determined.
Manganese	51.973–51.862		

The outcropping and float for 2 or more miles eastward along the base of Rich Mountain to the head of Deans Branch and down Staleys Creek to Currin Valley are very frequent. Currin Valley is a basin between Rich Mountain on the west, Wolf Pen Ridge on the south, and Pond Mountain on the north. It is about 1 mile in length and half this distance in width. Into it empty numerous ravines from the above-named mountains. Staleys Creek traverses its center from west to east. Along the foothills of the mountain the iron ore is found mixed with clay and sand, covering extensive iron deposits. Except explorative work for iron-ore beds, and these are not deep, no pits or shafts have been sunk to test the nature of the underlying formations. On a slight elevation of level land jutting out into this basin several hundred tons of manganese and manganiferous iron ore may be seen. The latter gives the following analysis by Professor Jarman:

Iron peroxide	36.75	Sulphur trioxide	.23
Protoxide manganese	17.28	Silica	23.42
Phosphorus pentoxide	1.62	Moisture	.807

From general appearance the manganese here carries a large percentage of silica.

The slopes of the mountain above this plateau is covered with ocherous clays and manganiferous sand.

MUNITIONS OF WAR.

BY

W. C. DODGE.

MUNITIONS OF WAR.

By W. C. Dodge.

PRELIMINARY HISTORICAL STATEMENT.

History shows that from the earliest ages man has devoted much of his time and attention to the production and improvement of weapons for hunting and for war, the former as a means for obtaining subsistence, and the latter for defense and conquest. It is not possible within the limits of this report to refer to the weapons used prior to the introduction of firearms, nor is it necessary, as they form no part of the exhibits to which this report relates.

Firearms were the result of the invention or discovery of gunpowder. The exact date when that occurred it is impossible to determine. For a long time the invention of gunpowder was credited to Roger Bacon, of England, who about 1249 published a pamphlet entitled The Secrets of Art and Nature, wherein he states that—

> From saltpeter and other ingredients we are able to make a fire that shall burn at what distance we please, and that sounds and coruscations resembling thunder and lightning might be formed in the air, much more to be dreaded than those that happen naturally, inasmuch as by its power cities and armies might be destroyed.

And in another chapter he says:

> Mix together saltpeter with luru mone cap ubre and sulphur, and you will make thunder and lightning, if you know the method of mixing them.

Bacon was a fellow of Merton College, Oxford, and familiar with Arabic writings. He did not claim to be the inventor of powder, and it is believed that he obtained his information from a book written by Marcus Græcus (Leiber Ignium), wherein was given not only the ingredients, but also their proper proportions, or from another Arabic writer mentioned by Hallam in his History of the Middle Ages, as more clearly referring to gunpowder.

In the Gentoo laws, supposed to be coeval with Moses, a passage occurs which Halhead translates thus: "The magistrate shall not make war with any deceitful machine, or with poisoned weapons, or with cannon and guns, or any kind of firearms," and in the Sanscrit, which has so long been a dead language, words are found answering to firearms ("aigmaster—weapon of fire") and cannon ("shangtee—killer of a hundred men at once.") As is well said by a learned

writer, many of these statements are to be taken with some doubt as to whether they refer to gunpowder or the celebrated "Greek fire" which was known to the rulers of Byzantium as early as the seventh century, and its composition ordered by them to be kept a state secret.

The Emperor Constantine, writing to his son, says:

> Thou shouldst, above all things, direct your care and attention to the liquid fire which is thrown by means of tubes, and, if the secret be asked of thee, as it has often been of me, thou must refuse and reject this prayer, stating that this fire had been shown and revealed by an angel to the great and holy Christian Emperor Constantine. By this message, and by the angel himself, it was enjoined to him, according to the testimony of our fathers and our forefathers, to prepare this fire but for Christians only, and solely in this imperial city; never to divulge it or allow it to be shown to any nation whatever.
>
> And to make certain of his successors' secrecy he caused to be engraved on the holy table of the church of God curses against whoever should reveal it to a foreign nation. He decreed that the traitor should be considered unworthy of the name of Christian, or of any trust or honor, and if possessed of any dignity should be deprived thereof. He proclaimed him anathematized forever; he declared him infamous, whosoever he might be, emperor, primate, prince, or subject, who should attempt to violate this law.

This was used in various forms, both as a liquid or semiliquid, and also as a solid.

Records, however, exist showing that gunpowder, as then understood, was known and used in China 700 years B. C., and, as some claim, 1,500 years B. C. It is certain that it was known and used in the East long before it was known to Europeans, and that it was brought from the East into Europe during the Crusades. The article as known and used in the early days was not, however, the gunpowder of the present day, but was similar to that used in rockets and other fireworks. Indeed, the guns and powder used in those days by the Chinese and other Eastern nations partook much more of the nature of fireworks than of modern firearms, they seeming to rely more on frightening their opponents by the fire and noise than on disabling them by the projectiles, some even claiming that they did not use projectiles.

According to Jervis it was not until about 1354 that "corned" or granulated gunpowder was invented by Berthold Schwartz, a monk of Cologne—an invention that was as important as the original discovery of powder, as it imparted to gunpowder a propellant force hitherto unknown, and which specially adapted it for use in firearms. In fact, so important was this invention that it has been claimed that he was the original inventor of gunpowder, and a monument was erected to his memory as such.

From the time when Schwartz made his invention down to a comparatively recent date, gunpowder remained essentially the same, there being some improvement in its quality and in the means used for its manufacture. One recent and important American improvement was

making it in the form of large grains known as "pebble" powder, or in perforated blocks, by which its combustion can be so regulated as to greatly increase the muzzle velocity of projectiles fired from large guns without increasing the bursting strain on the gun.

Since the invention of guncotton and many other more powerful explosives, new kinds of powder have been invented, the two principal kinds for sporting guns being the Schultz powder of England and the Ditmar powder of the United States. Both are made of wood treated with acids, the Schultz being formed from wood pulp, and is granulated, while the Ditmar is made from sawdust without being reduced to a pulp. Both are used in sporting guns.

For military arms, a new kind of powder known as the "smokeless" or nitropowder of various makes is being introduced and tested at the present time, and it bids fair to work as great a revolution in powder as there has been in arms. Although mining was an ancient art, gunpowder was not used for that purpose until early in the eighteenth century, the earliest mention of such use being in 1720. It is a singular fact that gunpowder was first used in cannon long before small arms were invented. The records show that it was thus used in the East long before it was in Europe. Elliott, in his index to the historians of Mohammedan India, says that allusions to cannon are made by Chased, a Hindu poet, who wrote about 1200; he speaks of their loud report, and of the noise of the ball being heard a distance of 19 coss, or 1,465 yards. Mohammed Shah Bahmiani, A. D. 1368, captured 300 gun carriages, among other spoil. The Portuguese, on their arrival in the East in 1498, found artillery in common use, and apparently of old date.

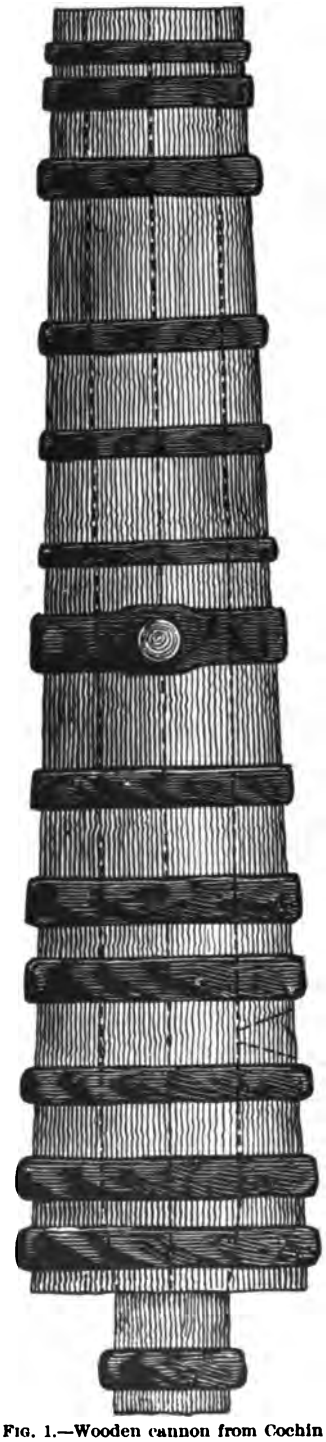


FIG. 1.—Wooden cannon from Cochin China.

In the Musée des Invalides, at Paris, is a Chinese cannon made of wood, as shown in figure 1.

It is composed of two longitudinal pieces of wood held together by 14 iron rings. The breech plug is also of wood dovetailed into the other pieces.

In the arsenal at Venice is a mortar of 18-inch bore composed of several coils of hempen rope covered with a thick casing of leather; and in the arsenal at Malta are preserved mortars made of paper with a covering of leather. These are of Eastern origin, and are believed to have been used at the time of the Crusades or before.

In 1308, at the siege of Gibraltar, Ferdinand IV, of Castile, employed cannon, and in 1311 Ismail attacked Bazas, in Granada, with "machines throwing balls of fire with a noise resembling thunder." The records also show the adoption in 1313 of—

A provision of the Republic of Florence granting to the priors, gonfalamarie, and 12 elders the power to appoint 2 officers, intrusted with making iron shot and metal cannon for the defense of the castles and villages of the Republic.

At the siege of Constantinople in 1413, Mahomed II had a cast-iron gun of 48-inch caliber, throwing a stone ball of 600 pounds, and, according to Amelgord, at the siege of Caen, in 1450, there were 24 great bombards, having a diameter at the muzzle so large that a man could sit upright in the bore.

In 1478, Mahomed II, at the siege of Santaria, in Albania, used bombards which threw stone balls weighing, respectively, 370, 500, 750, 850, 1,200, 1,500, and 1,640 pounds, the latter nearly equaling the weight of the shot of the 110-ton gun of the present day. According to the statement of General Lefoy, a French engineer, the stone balls used on that occasion weighed about 1,000 tons, while he estimates the amount of powder used at 250 tons. These balls were cut from the solid rock on the spot, and he estimates their dressed surfaces to amount to about 32,000 square feet.

The United States Government is in possession of a bronze Chinese cannon, captured from the Koreans by Rear-Admiral Rogers in 1871, bearing an inscription, which, as translated by the Chinese minister shows that it was made in 1312. It is a short breech-loading wall piece, of 2-inch caliber. This tends to confirm the statement of Captain Parish, who visited China, and who says that—

Two thousand years ago, the Chinese used jingals, or wall guns, or some firearm of that kind; and that in the embrasures in the great wall, built about 221 years B. C. he found small holes similar to those used in Europe "for the reception of the swivels of wall pieces, and that they appeared to be a part of the original construction."

Monsieur Parvey, in his report to the Academy des Sciences in 1850, says that it is mentioned in the books of the Chinese that—

In 608 B. C., during the Taing-off dynasty, they used cannon bearing the inscription, "I hurl death to the traitor and extermination to the rebel."

Cannon appear to have been introduced into Europe early in the thirteenth century. The records show that Seville was defended by cannon throwing stone balls in 1247. Mibela, in Spain, was also defended by "a machine resembling cannon" in 1259, and in 1273, Abou Yousof, at the siege of Sidgil-messa, used cannon throwing stone balls.

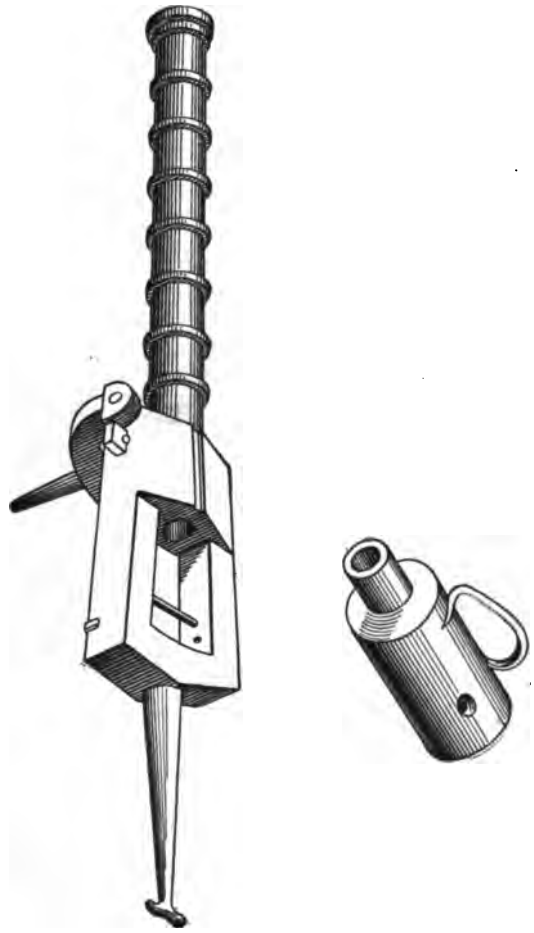


FIG. 2.—Early breech-loading cannon.

In 1338, among the stores of the hulk, *Christopher of the Tower of London*, were three iron cannon with five chambers, and in the barge *Marie de la Tour*, was one iron gun with two chambers, and another of brass with one chamber.

Most of these earlier cannon appear to have been breechloaders, and the chambers above mentioned were the breech closers, which had a chamber in their front end for the reception of the powder. (See Figs. 2 and 3.)

Among those who gave much attention to the art of war and warlike implements was Leonardo da Vinci of Italy, who not only designed many improvements in artillery, but also demonstrated the resistance of the air to the flight of projectiles, and the curvature of their trajectory. Even the steam gun, which was reinvented in recent years, and which at the beginning of our war, in 1861, was brought out by Winans, of Baltimore, with glowing expectations, was devised by this restless genius about 1502. It is illustrated by the accompanying figure (figure 4), and was thus described:

This is a brass machine which throws iron shot with great noise and violence. It is thus used. The third of this instrument consists in a great quantity of charcoal fire. When the water is very hot you must tighten the screw over the vase where the water is; and, by tightening the screw above, all the water will escape below,

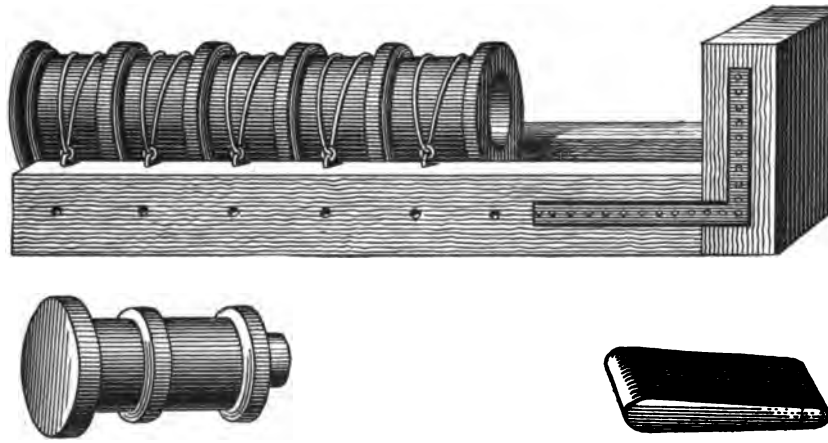


FIG. 3.—Breech-loading cannon of the fourteenth century.

falling into the heated part of the instrument, and will immediately turn into steam so abundant and strong that it will be marvelous to see the fury of this smoke, and to hear the noise it produces. This machine throws a ball of the weight of a talent and six.

The first mention of their use in England was by Edward III in 1327, and, as stated by Greener, they were imported from Flanders. Within ten years thereafter they appear to have become well known and common in Spain, Italy, France, and Germany.

Some of the earlier European cannon were made of bars of iron held together by bands. One now in possession of the United States Government, that was brought up by a dredging machine from the bed of the Hudson River at Albany in 1879, is thus described:

It is made of wrought iron, with projecting bands around the barrel. The bore runs from a calibre of 2 inches at the breech to 4 inches at the muzzle. The breech-closer is a block having a handle at the top, and a chamber for the powder in its front portion, which was reduced in diameter to fit in the bore, where it was fastened by a wedge or key driven through holes in the sides of the breech.

precisely as in the Chinese cannon captured from the Koreans, hereinbefore mentioned. It is believed to date back to early in the fourteenth century, and is said to be like the English cannon of that date. Its construction is similar to that shown in figure 2.

The improvement made in gunpowder soon after its introduction into Europe necessitated a change in the structure of cannon. They

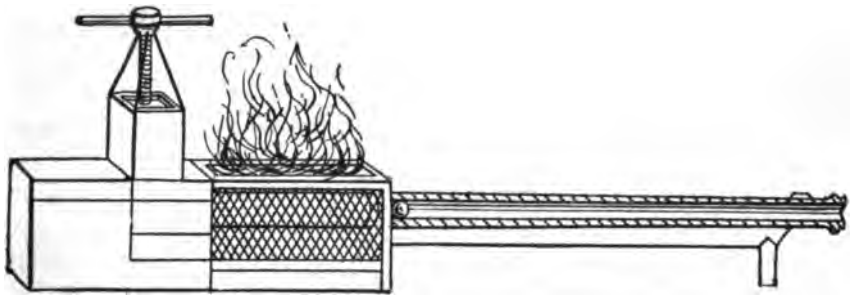


FIG. 4.—Steam gun, about 1502.

were made much stronger, generally muzzle loading and largely of brass or bronze, in which latter the German, French, and Spanish nations appear to have taken the lead. The first record of the use of brass for this purpose is of the date of 1378, when a founder named Aram, at Augsberg, in Germany, cast 30 cannon of a metal composed of copper and tin.

There are numerous records of the use of cannon in Europe from 1325 to 1365, but it is unnecessary to refer to them, as the present object is simply to trace the origin of firearms and show the various steps by which they have been brought to their present high state of efficiency.

SMALL ARMS.

The date of the origin of small or portable arms is as difficult to fix

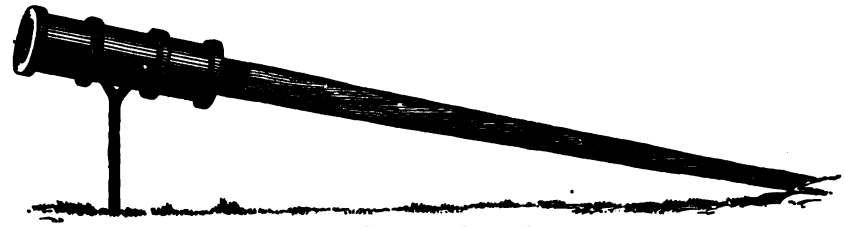


FIG. 5.—Earliest form of portable arms.

definitely as is that of cannon. One writer says they were first produced by the Italians in 1430, but mention is made in the Chronicles of Boulogne in 1397 of "hand cannon," or, as they are designated, "sclopos," and subsequently "sclopeto," and hence "escopette," "escopeta," etc. Valturius, who wrote in Latin, speaks of them as machines of war used by the Romans of antiquity, and he called

them ballista, from the name of the ancient ballistes of the Roman armies. They were also termed bombards, hand cannon, and culverins. At first they were simply small cannon fastened to a stick and fired from the ground, their front end being supported by a crutch or rest, as shown in the accompanying cut, figure 5.

FIG. 6.—Italian hand bomborde.

This may have been the kind of small arms mentioned as having been used at the battle of Creecy in 1346. They were sometimes made conical with a stem or handle at the rear end, as shown in figure 6.

The object of making the bore conical, as stated by one writer, was to enable them to fire balls of various sizes. Stone balls were generally used, and when it was proposed to substitute leaden balls they were objected to on the ground that they would sink into the earth when they struck, whereas the stone balls would rebound, and thus might wound more of the enemy. These statements will give to the reader a good idea of the inefficiency of the firearms of those days.

One of the first, if not the first, form of a gun to be fired from the shoulder is shown in the accompanying cut (fig. 7). As will readily be seen, it consisted of a conical tube fastened to a notched stick which rested upon the shoulder. The next change was to give a bend to the stock in order to bring the barrel more readily in line with the eye, as shown in fig. 8. These arms still had their touchhole on top like ordinary cannon, and were fired by a match carried in the hand, as represented in fig. 9, which also shows the manner of using them on horseback.

FIG. 7.—First form of gun fired from the shoulder.

As these early arms were generally too heavy to be held at arm's length, they were usually provided with a support, termed a crutch, the crutch, in the case of mounted men, being secured to or resting

on the pommel of the saddle. Soon, however, they were improved by the addition of one or more sights, with the touchhole at the side, and

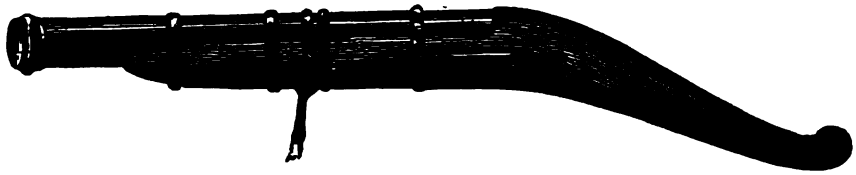


FIG. 8.—Early hand gun, with crutch or rest.

with a pan to hold the priming, and finally, by the addition of the matchlock, which in its earliest form consisted simply of a bent lever

FIG. 9.—Early hand gun as used on horseback.

pivoted to the stock to hold the burning match, and by which the latter was thrown down upon the priming in the pan to ignite the

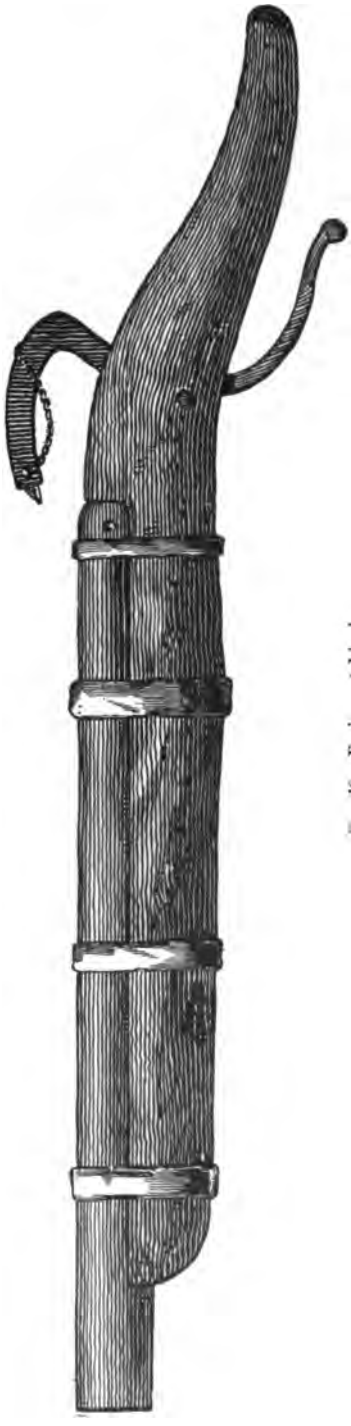


FIG. 10.—Early matchlock gun.

charge. The accompanying cut (figure 10) represents one of the earliest forms of the matchlock arquebus.

The guns used by the followers of Columbus and those who succeeded him, and which inspired the natives with so much awe, were doubtless matchlocks, as neither the wheel lock nor the flint lock was invented until subsequently. A curious arm of this class was brought from China to New York in 1861, by W. S. Livingston, an American residing at Shanghai. After the capture of the Peiho forts by the English troops, Mr. Wilson visited the place, and there found that the Chinese had laid down a large number of these guns to form a corduroy road, and he dug up this one and brought it home with him. The barrel was 8 feet long and weighed 22¾ pounds, the whole weight of the gun being 28 pounds. It was termed a "Jingal," and according to the statement, was used as shown in the cut, figure 11. In the exhibit in the United States Government building was one of these guns, the barrel of which was 14 feet long. It was brought from India, and kindly loaned to Captain Russell, in charge of the Government exhibit, by Messrs. Tillery & Co., agents for an India house. Some have expressed the belief that the Chinese used this kind of gun long before Europeans had small arms, but there is no record to show it, and it is quite probable that they obtained the knowledge of them from eastern Europe. The weight of some of these guns is shown by the statement that "Charles VIII, of France, in his expedition to Naples took with him 140 heavy guns, 200 bombards, and 1,000 arquebuses, each weighing 50 pounds."

Small arms appear to have spread in Europe almost as rapidly after their introduction as did cannon. They were used in towns much sooner than in the field. About 1364 the town of Perouse had ordered to be made "500 small cannon, a palm long, to be fired from the hand." (A Roman palm is 8½ inches.)

In 1381 the town of Augsburg had "30 men-armed with hand cannon," and the records show that in 1471, when Edward IV landed at Ravenspur in Yorkshire, he brought with him "300 Flemings armed with hand guns." These were followed by the musket, which was a larger and more powerful modification of the arquebus, and at first was fired with a crutch or rest. It was in use in Italy in 1530, in France in 1570, and in England prior to 1590. The caliver and fusil were simply lighter varities of the musket. The carabine or carbine was a short caliber with a large bore, and the blunderbus (or thunderbus) was still shorter with a larger bore.

The pistol was a miniature arquebus. It was common in Germany about 1512, was adopted by the French cavalry about 1550, and reached England a few years later. The petronel occupied a position midway

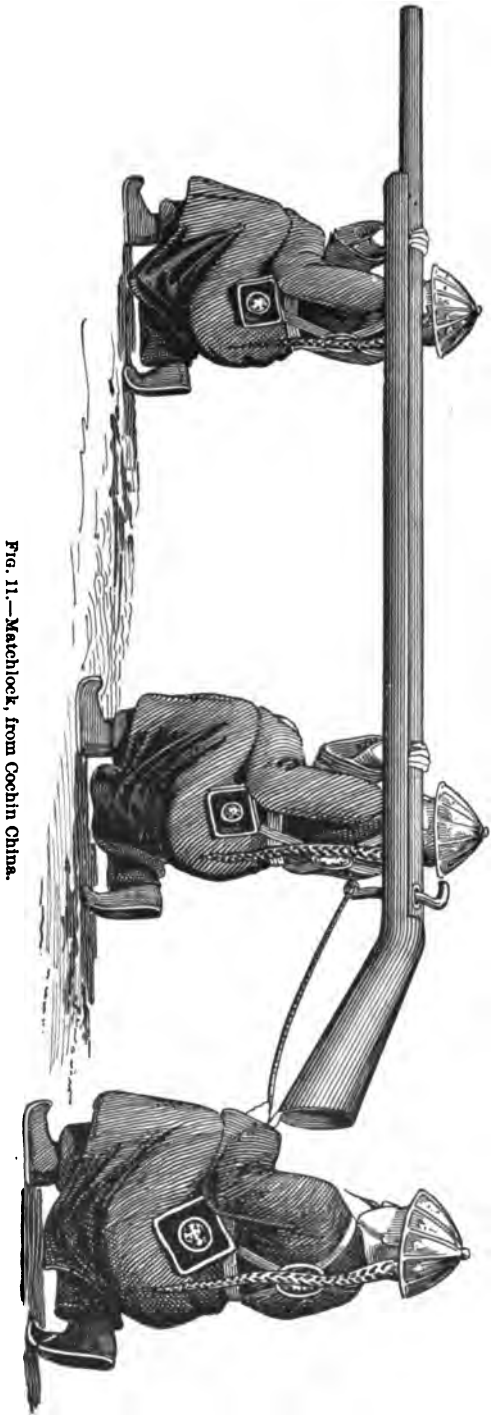


Fig. 11.—Matchlock, from Cochin China.

between the arquebus and the pistol, and was known in England as early as 1580, as was also the dag which was a long pistol of large bore with a curved stock.

According to Boutell, the names of animals were generally bestowed on ordnance, as the falcon, and its diminutive, the falconet, the musket deriving its name from the male young of the sparrow hawk, while the pistol is supposed to be so called because when first made its caliber corresponded with the diameter of the coin, pistole. There was also an arm known as the dragon, a kind of blunderbus used by mounted men, which gave to them the name of dragoneers, whence was derived the term dragoons, while grenadiers were soldiers who threw small shells or hand grenades. The scorpion discharged envenomed darts, and the onagar, a machine for hurling stones, derived its name from the wild ass of the desert, which was supposed to throw up stones with its heels when pursued.

MEANS FOR EXPLODING THE CHARGE.

At first firearms were discharged by means of a match carried in the hand, and which consisted of a piece of small rope soaked in a solution of saltpeter, so it would burn slowly and for a long time. This was succeeded by the matchlock, invented by the Germans about 1424. Then came the wheel lock, invented by the Germans about 1509, which was first applied to the carabine, a sort of a pistol, first used by the German cavalry against the French in 1554, much to the astonishment of the latter. It was soon applied to the arquebus or infantry arm. It consisted of a steel wheel made to rotate by a chain wound on its arbor and drawn by a spring, the flint being held on the wheel by a cock, which could be turned back when the lock was wound up by a key or crank applied to the projecting end of the axis, the same as a clock is wound up. A sample in the possession of the writer is also provided with a safety bolt, by which it is prevented from being fired until the bolt is withdrawn—a device that has been reinvented and applied in many forms to modern arms, both sporting and military. This was succeeded by the "snaphaunce" or flint rock, too well known to require description. Grose says, it originated with the Dutch about 1580, and is said to have been brought into use by a class of marauders termed "snaphaans"—hen stealers—who could not afford wheel locks, and dare not carry lighted matches for fear of detection. Locks were also made which combined both the match and the wheel, so that in case one failed the other might be used. The rebounding gun lock now in such general use in sporting arms, was of American invention, having been first patented in the United States in 1870. It was first embodied in a gun by the writer, and which is still in his possession.

The discovery of the fulminate of mercury by Bayen, of France, in 1774. opened the way for the invention of the fulminate since used for

igniting the gunpowder used in firearms. This was the invention of Alexander John Forsythe, a Scotch clergyman, who patented it in Great Britain, April 11, 1807. It was first used in the form of powder, and was ignited by a punch, and hence the term punch lock. Subsequently it was used in the shape of small pellets, termed "pills," which were ignited by the blow of the hammer of the lock, guns made to use pills still being found among old arms in the United States and elsewhere. It was also used in the form of pellets secured between two strips of paper in small tubes and with various other devices.

A great many patents were also taken for magazines in the lock and on the barrels of guns for holding and feeding the pellets or other forms of fulminate to effect the discharge, one such being the United States patent to Walter Hunt in 1848. These, however, never came into general use, and were superseded by the percussion cap, which at first was made of paper. The copper cap was invented in 1818, but by whom it is difficult to tell, as it was claimed by nearly every gun maker in England. It was introduced into the United States by Joshua Shaw, of England, in 1842, who was paid $18,000 for it by the Government, although he could not patent it here, as the law at that time did not permit the grant of a patent to an alien. This and the granulation of powder were two of the most important inventions ever made in reference to firearms, and the percussion cap in one form or another is universally used in small arms and rapid-fire guns to the present day, but is applied to the metallic cartridge instead of the nipple of the gun. With heavy guns a friction primer, invented by Coston, in the United States, in 1845 or 1846, was formerly used, but is now being superseded by electricity.

RIFLED GUNS.

The greatest improvement in firearms was the rifling of the bore. This was first done at Vienna about 1498. At first, however, the rifling consisted of straight V-shaped grooves, which were adopted simply as a means of more easily getting the ball down, and which was driven down by a mallet in many cases, and as receptacles for the residuum produced by the burning of the powder in the barrel. Such rifling was of little or no value. A gun maker of Nuremburg, in about 1523, first gave to the grooves a spiral form, by which a rotation is imparted to the projectile around its center of gravity, thereby vastly increasing the accuracy of its flight and enabling elongated projectiles to be fired without tumbling, the rapid rotation keeping them end on.

The first general use of rifled small arms is said to have been by the American colonists in their contests with the Indians, and in the Revolutionary war, in which the American riflemen gained great renown.

In Berlin is a rifled cannon of 1664, and in Munich is another of per-

haps equal antiquity. The French carbineers had rifled arms in 1692.

Robbins, in his treatise published in 1734, strongly urged the adoption of rifles, and also that they be made breech-loading; but it has taken over a century and a quarter to convince military officials of their advantages, though now their use is universal.

THE VARIOUS KINDS OF SMALL ARMS.

Want of space forbids a description of the various forms in which small arms were made; but, in addition to those already mentioned it may be stated that a series of barrels or guns were mounted in a frame on wheels, with a shield in front to protect the men, and that in addition long spears were sometimes interposed and made to project in front. Pistols were also applied to shields with their muzzles protruding through a hole at the center. They were also applied to the handles of swords, battle-axes, and other warlike implements, and also to the butt of a heavy whip carried by mounted men.

REVOLVING FIREARMS.

Revolving firearms were made early in the fifteenth century, there being many specimens of them in the various museums of Europe, some with matchlocks, others with wheel locks, and one with a flintlock, with devices for drawing back the covers of the powder pans as they are brought successively to the top by the rotation of the cylinder.

A curious revolver was patented by James Puckle in England in 1717. The chambers extend entirely through the cylinder, like those of the present day, and the charges were placed in metallic charge holders which were inserted in these chambers, apparently from the front. The cylinder was rotated by a crank, but how fired it is impossible to tell, the patentee, who appears to have been an excessively loyal man, saying that he would not give the details lest the enemies of the king might learn how to construct the arm. It is represented as of large size, mounted on a tripod with a swivel which permitted it to be turned in any direction, and was provided with means for adjusting the barrel vertically at any desired angle. One of the curious features of this arm was that it was provided with round chambers for shooting round balls against Christians, and square chambers for shooting square balls against infidels. Revolving firearms, however, were not a success, and did not come into general use until the invention of Colonel Colt, who obtained his first patent in England in 1835 and in the United States in 1836, but did not perfect his arm until 1845. Since then they have come into universal use, both for military and private use. The features which made Colt's revolver a success were the mechanism by which the cylinder was rotated in the act of cocking the hammer and the means for locking the cylinder when rotated, so as to hold the chamber to be fired in exact line with the barrel.

An English author has claimed that Colt's invention was anticipated by a revolver in the Tower of London, of which he gives an illustration, but in that the cylinder is rotated by the falling of the hammer, a plan that is utterly unreliable, because in that case the mainspring has not only to operate the hammer but also to rotate the cylinder, which it would never do with certainty, especially when obstructed by foulness or rust, as is generally the case. By Colt's invention the cylinder is rotated positively by the power of the hand in the act of cocking, this power being more or less as may be required, thus leaving nothing for the mainspring to do but to operate the hammer. It was just this difference, which the writer had failed to observe, that converted failure into success, and which justly entitled Colt to the credit he received as the real inventor of a successful revolving firearm.

The extractor now in general use on revolvers was invented by the writer in 1861, and patented by him in 1865. The ingenious mechanism by which its action is rendered automatic on opening the arm was devised and applied by Smith & Wesson.

MAGAZINE OR REPEATING GUNS.

Magazine or repeating guns, although but recently adopted for military use, have been known for many years. The first in the United States was patented by Day in 1837, and others, followed by Hunt in 1849, Smith in 1851, and by Smith & Wesson in 1854, the latter being the foundation of the celebrated "Winchester" of the present day.

HAMMERLESS GUNS.

Although what is known as "hammerless" guns—that is, guns in which the hammer is concealed by being located inside the frame—have but recently come into general use, they are of early date, specimens still being preserved in the museums of Europe, of the wheel lock and other varieties. The term is a misnomer, as the so-called "hammerless" guns are provided with hammers inside instead of outside of the frame. "Concealed hammer" would be a much more accurate term.

BREAKDOWN OR DROP-BARREL GUNS.

This style of gun, which is used exclusively for sporting purposes, dates back to 1812, it having been patented in France by Pauley at that date and in England in 1816. He proposed to apply the idea to both cannon and small arms, but his plan never came into use; first, because he pivoted the barrel on trunnions at the sides, which necessitated forming the rear end of the barrel and the front face of the breech piece in the arc of a circle, and which it was difficult to construct with accuracy in the then condition of metal-working machinery; second, because, although he proposed to use a metal case

for the powder, it was simply a tube with a wooden head or "rosette," and could not be rendered gastight and secure. He proposed to close the joint and render it gastight by the use of a ring of lead which was to be forced into the joint around the head of his shell by the explosive force of the charge, similar to Morse's cartridge patented in the United States in 1856, but which also never came into use. He proposed to ignite the charge by the compression of air by means of a small piston.

To M. Lafaucheux, of Paris, is due the credit of having rendered this style of arm practicable in 1835, and so valuable were his improvements that they were universally adopted for double-barreled shotguns. Lafaucheux was a workman with Pauly at Paris, and in 1835 he submitted to the Society for the Encouragement of National Industry his improved gun and cartridge, on which an elaborate and eulogistic report was made by Baron Siguier, chairman of the committee of mechanical arts. His improvement consisted primarily in hinging the barrels to the frame at their underside, whereby a flat-faced vertical breech shoulder could be used, the rear end of the barrels being cut square off to fit against it when closed—in securing the barrels firmly to the frame by lugs on the underside of the barrels and locking the barrels in position by a lever—features which, with some variations, have continued in use to the present day. He also submitted a military gun firing a charge of 70 grains of powder, which was tested and favorably reported on by M. Oliver, chairman of the committee appointed to test his guns. His other, and perhaps more important invention, consisted in making a cartridge shell which would, by its expansion and pressure against the walls of the barrel by the force of the gases within it, make an absolutely gas-tight joint at the instant of the discharge. In speaking of this feature, the report, after alluding to the leakage of gas in prior breech-loading guns, says:

> The flexible edges of this hat (brass cup) dilating at the moment of explosion, and applying itself to the sides of the barrel with such exactness that henceforth the slightest escape of gas becomes impossible.
>
> This method, which is as simple as it is ingenious, and which an observing mind has known how to borrow from the hydraulic press to make of it a happy application, deserves to fix your attention. We look upon it as one of the most useful improvements applied for a long time to sporting arms which are loaded at the breech; for by its use the combination of closures which are less exact, will be safe from the escape of gas, and henceforth it will not be the exactitude but only the solidity of the closure which renders the problem of the manufacture of arms with broken breech difficult to solve.

So far as can be found from a careful search of the records, this is the first description of the principle on which all metallic cartridges operate, and which rendered breech-loading guns practicable. The same idea was described in the United States patent to D. Minnessinger, in 1849, who had no knowledge of what Lafaucheux had done.

I have dwelt upon this, because all agree that this invention is of as great importance as that of loading at the breech, and because the credit of it has been claimed in recent official publications for other parties, and of much more recent date.

In 1871 the writer invented means for compensating for the wear of the parts, by which the barrels can be always kept tight on the frame, a feature since adopted by several makers of this style of gun.

THE BAYONET.

As to the origin of the bayonet, there is as much uncertainty as to that of small arms. Most writers have stated that it originated with the French at Bayonne in 1682, and hence the name bayonet. It was, however, known in France as early as 1570, and was in common use there on firearms in 1640, it being used by troops instead of the pike. At first it was simply a dagger, the handle of which was stuck into the muzzle of the gun. Who first made it with a socket to fit over the barrel, so that the gun could be fired with the bayonet on, is uncertain. Its origin has been accredited to Vauban of France, 1633–1707; Mackey of England, 1691; and to Coehorn of Holland, 1704. In Coehorn's writings on the Dutch army in 1681 we find this statement: "This bayonet devised by me can be so fastened on the musket that it does not interfere with shooting," etc. There was, however, a strong contest between him and a Dutch engineer, Capt. L. Paen, with regard to the credit for the invention of the socket. In the Culeman collection at Hanover is a wheel gun of the sixteenth century with a bayonet having a socket, and in the sixteenth century a bayonet having two rings, by which it was secured to the staff of a lance, was used. With the modern improvements in long-range firearms, the bayonet, which in Napoleon's time was so important, has now become of little account as a weapon.

THE MANUFACTURE OF FIREARMS.

Formerly this work was performed almost entirely by hand, while at the present time it is performed almost wholly by machinery, and which was rendered possible only by the invention of the "interchangeable" system, or the making of the parts in exact duplication so that any one part would fit equally well in any and all guns of the same make. It is uncertain who first conceived the idea, but it appears to have originated in France as early as 1722. The plan was tried on gunlocks by order of the Government for about ten years, and then abandoned. The plan of thus making gunlocks was taken up by M. Blanc, superintendent of the royal manufactory of arms at St. Etienne about 1778, but met with great opposition from the skilled workmen and others; and though his plan was indorsed by a committee of the Academy Royal des Sciences, it was condemned by a military commis-

sion, on the ground that it was expensive and inexpedient. In 1797–1798 he engaged in the business of thus making gunlocks on his own account. Prior to this, however, in 1790, Eli Whitney, the inventor of the cotton gin, who had taken a contract to manufacture muskets for the United States Government, conceived the idea, and applied it to the entire arm. The idea is believed to have been entirely original with Whitney, who appears to have had no knowledge of the efforts of others in that line. He encountered great difficulty in carrying out his idea, mainly because of the nonexistence at that time of suitable machinery for doing the work, much of which he had to devise and make for himself. The system was adopted in the United States arsenals as early as 1814, and since then by all private manufacturers in the United States, not only for firearms but for many other articles of metal. This system was introduced into England from the United States in 1850, a set of machinery for the manufacture of Enfield rifles being made at Windsor, Vt., by Lawrence and others, for the British Government. Nearly all the machinery used for that purpose is of American invention; and the high degree of efficiency to which these various machines have been brought excites the astonishment of all who witness their operations for the first time, most of them being automatic and requiring the workman only to put in and take out the pieces of metal being operated upon, start the machine, and keep the tools in order.

Another important invention was the lathe for turning irregular forms, by which the stocks of nearly all firearms, as well as many other articles, are now made. This was the invention of Thomas Blanchard, of Massachusetts, who patented it in 1819.

CARTRIDGES.

Originally the powder and bullets used in firearms were carried separately, the former in flasks or horns, and the latter in bags. About 1550 "bandoleers" were introduced, consisting of shoulder belts, from which were suspended a series of small cases, each containing a charge.

To Gustavus Adolphus history gives the credit of first devising a cartridge by uniting the powder and ball in a paper case in 1630, and in that form they continued to be used for military arms down to a recent period.

Although metallic cartridges were not adopted by the United States Government until 1868, they are of a much earlier origin. Charge chambers, made of solid metal bored out to contain the powder, were shown as early as 1718, and in American patents for breech-loading guns as early as 1839.

Shells of brass or copper for small arms seem to have originated with the French, the earliest being shown in the patent of Galay Cazelat of 1827. It is shown as a tapered shell with a central recess or pocket in

the head, in which the fulminate was placed, and ignited by the friction of a needle operated by a spiral spring, similar to that of the German needle gun. The cartridge is described as "a very thin brass envelope (cylinder) in one single piece without soldering." It is also provided with a radial flange at the rear end. How made it is impossible to tell with certainty. So far as can be learned from the meager description, the head is thought to have been a separate piece placed loosely against the rear end, and held in place by a small piece of parchment tied over it, and which he says was to protect the fulminate from moisture. Such a cartridge would obviously be of no use with the charges used in modern arms.

DRAWN METALLIC SHELLS.

The first record of a cartridge shell drawn up from sheet metal by machinery, as is now the universal custom, appears to be that of an American by the name of Palmer, who, in 1854, at Paris, submitted to the Society for the Encouragement of National Industry a machine for that purpose. It was reported upon by a committee, and is illustrated in the journal of the society, but he does not appear to have patented it at home or abroad.

A great deal was done by the French in devising breech-loading sporting guns, and cartridges for the same, from 1845 to 1860, but the shells used were of paper with brass heads, generally of the pin variety, although as early as 1853 they were described in patents as being made of metal, and with a primer set in a central recess or pocket in the head, somewhat similar to those now in general use.

Drawn or punched-up copper shells appear to have been used by Flobert in small rifles, and by Lafaucheux in revolvers as early as 1853. The first in the United States was a center-fire copper cartridge patented by Smith & Wesson in 1854; and in that year small rim-fire cartridges were made by D. B. Wesson, at Springfield, Mass., and by Allen of Worcester, about 1861.

The first factory for the manufacture of metallic cartridges of various sizes for all kinds of small arms was established at South Coventry, Conn., by Messrs. Crittenden & Tibballs about 1862. In 1864 they were succeeded by what is now the Union Metallic Cartridge Company of Bridgeport, Conn., where, under the supervision of Hobbs, who became famous by picking the Bramah and other locks at the English Exhibition, they began the manufacture on a large scale, both for sporting and military arms, their first foreign contract being 9,000,000 for the Russian Government. Prior to that, in 1858, the New Haven Arms Company, subsequently reorganized as the Winchester Repeating Arms Company, made rim-fire copper shells of 44 caliber; and in 1870 the latter company erected an extensive plant for the manufacture of all styles and sizes of metallic cartridges. Various

other establishments have also made them, especially one at Lowell, Mass., but the Union Metallic Cartridge Company and the Winchester Repeating Arms Company manufacture the great mass of those used in the United States, and send large quantities to Canada and other countries. At first these cartridges were made of copper, and were rim fire, but brass was soon substituted because of its greater elasticity and consequent less liability to stick in the chamber after being fired, and they were made center fire by fitting a short cap or primer in a pocket formed in the center of the head or base of the shell. As the charge of powder was increased, much difficulty was encountered by the bursting of the shells at the rim, there often being slight fractures caused by forcing down the metal to form the rim, these being imperceptible to the naked eye. Many improvements were adopted to remedy this defect, the principal one being the insertion of a metallic cup and pasteboard wads as a reenforce to the head and flange, a plan devised by the French as early as 1850 or before.

About 1869 the solid-headed shell was invented, which has proven to be one of the most important improvements in metallic cartridge shells ever made. This is accomplished by using thicker metal for the shell, and instead of folding the metal to form the flange, it is formed by a pressure sufficient to cause the solid metal to flow outward into the annular recess of the die, thereby producing a head and flange of solid metal; and in addition the walls were made thicker near the base. This form of shell was patented by Hotchkiss, of the United States, in 1869. The machinery for making these appears to have been almost, if not entirely, of American origin; and soon after the business was commenced by the Winchester Company, improvements were made which render them practically automatic, an attendant being required simply to keep the machines supplied with material, and see that they do not get out of order. The extent to which improvements have been carried may be seen when I state that solid-headed brass shells are now made for rapid-fire guns, from 4 to 8 inches in diameter, and from 2 to 4 feet in length, they being drawn up from a single piece of sheet brass. Such shells of 4-inch diameter were shown in the exhibit of the Union Metallic Cartridge Company and in the French exhibit, and 4 to 8 inch shells in the exhibit of the Winchester Repeating Arms Company. The manufacture of these shells, like that of making fire-arms with their parts interchangeable, was introduced into Europe from the United States, the first set of machinery for that purpose having been sent to Russia by Governor Winchester in 1878.

In consequence of the refusal of the ocean steamers to carry cartridges, as they were supposed to be dangerous, Governor Winchester, in order to supply cartridges for his guns abroad, arranged with parties to manufacture the cartridges in Europe; but after trying it they failed.

On sending one of his skilled operators over there to ascertain what the difficulty was, he found that the trouble arose from the simple fact that they did not anneal the shells during the half dozen or more operations, each operation of drawing and working the metal hardening and crystallizing it, so that when the flange was finally formed the metal cracked. He erected an annealing apparatus and showed them when and how to anneal them, and thereafter they had no trouble. Soon after trials were made by placing boxes of loaded cartridges on railroad tracks and running cars over them, and in other ways, by which it was demonstrated that they could be shipped with safety, and they are now shipped to all parts of the world.

OPPOSITION TO FIREARMS AND IMPROVEMENTS.

In looking back over the history of firearms the fact which now strikes the mind with the greatest force is the slowness with which improvements have been adopted. But this is nothing new. In fact, when firearms were first introduced into England there was strong prejudice against their use in any form.

Says Deane, in his Manual of Arms:

So tenaciously, indeed, was this predilection for the long bow evinced in England that as late as the reign of Elizabeth, when firearms had become elsewhere of universal use, the prejudice against them was so strong that the general opinion expressed itself openly against their use; and to strengthen the popularity of this prejudice, it was even vested with a religious garb; for at that period in England the extension of the use of firearms was considered in the light of a very calamity, and people were found who prophesied the downfall of the state itself from their more general introduction. Not only during the reign of Elizabeth was the use of the favorite bow the popular theme, and a treatise thereon written by Robert Aschan, 1589, but as late even as the days of Cromwell, Jervase Markham, 1634, wrote upon the subject, exhorting the Government to return to the use of the bow, and reestablish the archer-militia of England. And no less a person than Blaise de Vigenere, in his Art Militaire, 1593, contended that the long and cross bows were more effectual weapons than firearms. The philanthropist, Michael Montaigne, also predicted that he would live to see the abolition of firearms, while the French General Latrille declared the time would come when artillery would only be used for the defense of fortresses.

Says the author of the Hand Book of Hythe:

Although the rifling of the gun barrels was discovered almost as early as was this continent, and though more than a quarter of a century ago Robins fully pointed out nearly every improvement since made in the rifle, even to the elongated ball and breech loading, still it was only within the past few years that the rifle has been introduced into general use as a military arm, so slow were military men to see or acknowledge its superiority. So, too, after the match had been supplanted by the pyrite or wheel lock, and that again by the flint, it was with the greatest difficulty that the latter could be displaced by the percussion cap. So strong was the prejudice in favor of the flint that the percussion principle was in general use in France for nearly half a century before it was adopted in England, although invented in the latter country.

And Greener, in his work, details at length the experiments to which

he was compelled to resort in order to convince people of the superiority of percussion over flintlocks, and that, too, within comparatively recent years.

Scoffern, in speaking this opposition, says:

> In proportion as the manufacture of small arms improved, their advantages could not fail to be in some degree appreciated. Prejudice, nevertheless, strongly operated against their general application. Indeed, the prejudice against even cannon was at first very strong on the part of the knights. The introduction of cannon was a sad blow to their chivalry. Loudly did they protest against the villainous saltpeter; loudly they inveighed against such unknightly modes of fight. The force of public opinion, however, was too strong for their prejudices. * * * But when the ungentle musket began to supplant the bow, what a terrible innovation was there! Deep and loud were the execrations of the knights; low the mutterings of the armorers, who began in near prospective to see their occupation gone. For a period the strength of armor was increased; breastplates acquired the thickness of anvils; helmets became like cooking pots; horses tottered under their heavy loads; and knights were not infrequently smothered in the fray. It was useless longer to effect disgust at innovations; the day of chivalry had passed; knights felt that they were no longer the strength of the army, nor did their armor secure them immunity from injury and death. Gradually, then, manual weapons of firearms were universally employed; the soldier threw away his armor, the knight relinquished his lance, rapid evolutions succeeded to the slow but ponderous charge, and the whole system of war changed.

There were several reasons for this opposition. The haughty barons opposed their general use by the populace, because it would increase their power of defense, and to the same extent lessen the arbitrary power exercised by the ruling class. Napoleon, in his preface to his treatise on the Past and Future of Artillery, says there were two reasons for the opposition by officials, first, the complication and imperfection of the arm submitted, and, second, the opposition of routine. He, however, lays the greatest blame upon the opposition of routine, "which, being enamored with old ways, has preserved for ages practices that are most stupid; and not only does routine scrupulously preserve, like some sacred deposit, the errors of antiquity, but it actually opposes, might and main, the most legitimate and the most evident improvements." It was the same in the United States, for although the Government soon after the war of 1812 adopted Hall's breech-loading gun, patented in 1811, and had it made at Harpers Ferry Armory in 1814, and in order to familiarize the people with it Congress authorized one to be given to each member of Congress to take home to show to his constituents, and although as improved by Savage & North the Government had a large number of them made for the cavalry, some of which were used in the war with the Seminole Indians and with Mexico, still when our war broke out in 1861 the then Chief of Ordnance strenuously opposed the adoption of breechloaders, as did also the Secretary of War a few years before; and when, in 1862, the writer tried to secure the adoption of breechloaders by

the United States Government, and published a pamphlet showing their advantages, he was denounced as a "crank."

The then Chief of Ordnance insisted that breech-loading and magazine guns were utterly impracticable and unfit to put into the hands of the common soldier, saying "they would fire too fast and waste their ammunition," and that "the best arm ever made was the old smooth-bore flint-lock musket," adding that "it was old Brown Bess and the bayonet that decided battles." His successor in like manner opposed them, and said that no nation had ever proposed to arm infantry with breechloaders, notwithstanding the fact that the reports of Majors Mordecai, McLelland, and Dellafield, who had been sent to Europe in 1858 to examine the arms and equipment of European troops, had officially reported the fact that breechloaders were used in the Norwegian navy; that one battalion of each regiment of the German army were armed with the needle gun, and they were running their works day and night to provide them for the entire army; and that the *Cente guarde* at Paris were armed with a breech-loading metallic-cartridge gun which had proven so effective that its adoption for the entire army had been recommended by the chief of ordnance. With the appointment of General Dyer as Chief of Ordnance there was a change. Several of the subordinate officers of the Bureau were strongly in favor of breechloaders, while the demand of the volunteers in the field was unanimous for them, several regiments when asked to reenlist making it a condition that they should have the improved guns, and offering to pay the difference in cost out of their own pockets, so anxious were they to have them.

From the first, the cavalry were armed with breech-loading carbines; and the superiority of breechloaders over muzzle-loaders was so effectively demonstrated by General Berdan's sharpshooters, who were armed with Sharp's rifles, that the improved arms were gradually adopted.

The earliest use of breechloaders by infantry in our late war, was by a rifle company in the first regiment of three months volunteers from Connecticut, raised by Senator Hawley, in the spring of 1861, who purchased 75 Sharp's rifles for the men on his own responsibility.

The first repeating guns used were 1,200 Henry magazine guns ordered for Colonel Baker's regiment of cavalry, raised in the District of Columbia, and several regiments of infantry were subsequently armed with them, and they were used in Sherman's march to the sea, and elsewhere.

About the same time the Spencer repeating arm made its appearance, and was used with such effect, especially by General Wilder's brigade of mounted infantry, that a contract for 70,000 was made by the Department, but they were not delivered until after the war

closed. In the meantime the Remington and various other styles of breechloaders made their appearance, and so strong became the popular feeling that all opposition ceased, and soon after the close of the war the Department officially adopted a breechloader. The opposition to magazine or repeating guns still continued however, the Chief of Ordnance in his official report as late as 1886 recommending the continuation of the use of the single breechloader in preference to any repeating gun then in existence. The result is that now after every nation in Europe has adopted repeating guns, nearly every one of which is a mere modification of American inventions, our Government has finally concluded to do the same.

It is a remarkable fact that nearly every invention adopted by the Government, from the *Monitor* down to the latest improvement in a gun or a cartridge, has originated with civilians, and has literally had to fight its way against the opposition of officials. At the present time, however, there seems to be a more friendly feeling toward improvements, and several of the subordinate officers, both in the Army and the Navy, have themselves made some valuable inventions in their respective lines.

RECENT IMPROVEMENTS.

A vast number of improvements in breech-loading and repeating arms have been devised, as was shown by the exhibits to which reference will be hereinafter made. The most important changes in military arms have been the adoption of the breechloader and the metallic cartridge, and now of the repeating arm with its magazine located centrally, of which the Lee gun was the first, and the adoption of the reduced caliber, both of which have now been adopted by the United States and all European and South American Governments. The caliber of military arms now ranges from 0.236 to 0.315 of an inch. The bullets consist of a jacket or shell of sheet metal composed of copper and nickel, filled with lead and antimony, though the jackets are sometimes made of steel, but this, being more liable to rust and injurious to the rifling unless patched, is not generally used. This style of bullet is of American origin, it having been designed and used by the Winchester Repeating Arms Company in a trial of the Hotchkiss gun at the Springfield Armory in 1879. One form of it was patented to Leonard Geiger, the inventor of the Remington breechloader, in 1884, and another form of it by T. G. Bennett, of the Winchester Repeating Arms Company, in 1886.

Another important change has been the adoption of the smokeless powder, which is just coming into use. These improvements in small arms bid fair to change materially the art of war, as the small caliber bullets have a range of from 2 to 3 miles, and as shown by recent experiments, will pass through four or five men at 110 yards, and two or three at 900 yards.

As illustrating the great advance made, it may be stated that the penetration of 12-inch pine boards was the capacity of the military rifle at the commencement of our war in 1861; and when in 1863 one was produced which penetrated 26-inch boards it was thought to be something remarkable.

Within the past few years, at a trial at the Washington Navy-Yard, a steel projectile 1.07 inches long, of 0.32-inch caliber, penetrated solid iron 1.15 inches, fired at an angle of 80 degrees. It also penetrated 50 inches of pine boards, and its range is estimated at about 3 miles—much farther than an object of the size of a man can be seen. This idea of a reduced caliber was advocated by the writer in 1862, and a strong effort was made to induce the Sharps Rifle Company to adopt it; but at that time neither military men nor private manufacturers could be induced to adopt it.

The improvements in ordnance or cannon has been equally great. In 1732, 600 yards was considered a sufficient range for artillery. As late as 1860 4 miles was considered a long range, and when, in 1863, General Gilmore planted his "swamp angel" about 5 miles from Charleston, a leading English paper ridiculed the idea, and said that "no gun had been made that could throw a projectile 5 miles." Since that, so rapid has been the improvements in the construction of cannon and in the powder used, that the whole aspect has been changed. Steel has been substituted for cast iron, the length and the power of the guns have been enormously increased. As illustrative of the advance made since 1865, it may be stated that the penetration of iron armor by our 15-inch cast-iron guns, the largest made, was but 6 inches at the muzzle and but 3½ inches at 1,500 yards. With the present built-up steel guns, the penetration ranges from 8.04 inches for the 4-inch guns up to 35.42 inches for the 13-inch gun at 1,500 yards, and 32.32 inches at 2,500 yards.

In an experiment abroad it is reported that a 63-ton British gun sent a 13½-inch projectile weighing 1,120 pounds through an 18-inch compound plate, 6-inch wrought-iron plate, 20 feet of oak backing, another 10½-inch plate, and was found sticking in a 2-inch iron plate; that is, 34½ of iron and 20 feet of oak. It is also reported that in a recent trial one of the 110-ton British guns sent a 16-inch projectile through 20 inches of steel armor, 8 inches of iron, 20 feet of oak, 5 feet of granite, 11 of concrete, and 3 feet of brick. A French 47-ton gun is reported to have penetrated at short range 32.62 inches of steel armor, and at 1,500 yards 19.69 inches. The great Krupp 124-ton gun with its projectile weighing about 2,600 pounds will penetrate 3.53 feet of wrought iron near the muzzle and 3.01 feet at 2,000 yards. Some of these big guns use as much as 700 to 900 pounds of powder, and the cost of firing them with their projectiles ranges from $1,000 to $1,500 at each discharge.

Another great improvement of recent date is what are termed "rapid-fire guns." These are simply breechloaders using a metallic cartridge, the same as in small arms. They are now made of all sizes from 2 to 8 inch caliber, the brass shells for the latter being 4 feet long. The breech mechanism of these guns has been so improved of late that the 5 and 6 inch guns have been fired at the rate of 5 rounds in 24 seconds, and in one instance 5 rounds in 17 seconds, thus having from 3 to 5 shots in the air at once. As to the range of these modern guns, it may be roughly stated at a mile per inch of caliber; that of the 13-inch gun of the United States Navy being estimated at 13 miles, and other sizes in proportion. In this line improvements are still being made, the French having experimented with a 6.3-inch gun 90 calibers, or 47 feet 3 inches long, with 80 pounds of smokeless powder and a 90-pound projectile, which gave a muzzle velocity of 3,900 feet per second, with a pressure of but little over 16 tons per square inch.

In a wire-wound experimental American gun of 5-inch caliber, 19 feet 2 inches long, with American smokeless powder, a pressure of 75,000 pounds per square inch was obtained. One shot gave a muzzle energy of 3,557 foot-tons or 857 tons of energy per ton of weight of gun, or 169 foot-tons of energy per pound of powder. This it is said exceeds any record yet obtained for any gun or powder.

When armor was first adopted it was a question as to whether guns could be made of sufficient power to penetrate the armor that a vessel could carry; and it soon became a struggle between the thickness of armor and the strength of the gun.

At first armor was composed of a series of thin iron plates, then of thick iron plates, then of iron faced with steel, and all steel, and now of nickel-steel, and finally of nickel-steel "Harveyed"—that is, hardened on its face by the Harvey process, by which its power of resistance is increased 100 per cent up to 6-inch plates and proportionally less for thicker plates. Step by step as the thickness and resistance of the armor was increased, the power of the gun was increased until finally it was found that the projectiles failed to penetrate but were broken up. Then inventors set to work to make stronger projectiles. At first they were made of chilled cast iron, but even these were smashed, and now they are made of peculiar qualities of steel; and to such a degree of perfection have they been brought that a 6-inch projectile has been fired through a 9-inch compound plate and was finally broken up on another plate specially prepared. In another instance a 9.2-inch projectile penetrated a 16½-inch iron plate and went 8½ inches into a second plate.

The thickest armor ever put on a vessel was 24 inches, and that only on a portion of the vessel, so great was the weight. At the present time steel only is used for armor, as by its use the weight for a given resistance can be lessened about one-third. There is a known limit to

the thickness of armor that a vessel can carry, but there is no known limit to the power of the gun, powder, and projectile of the future; and as shown by the trials above mentioned, already there are guns capable of penetrating the thickest armor afloat or that any vessel can carry and float, as the writer in 1863 predicted would be the case.

From the foregoing the reader will be enabled to get a very fair idea of the advance made in firearms and ordnance since the discovery of America by Columbus; and although many of our modern improvements were conceived at an early date, it is only within the present century that they have been embodied in practicable form and rendered useful, and largely within the past quarter of a century.

Aside from the invention of gunpowder itself, it is safe to say that more improvements and advance have been made during the past forty years than during all the preceding ages, due, no doubt, to the more general diffusion of knowledge and skill among men, the rapid improvements in metallurgy and machinery, and the inducements held out by the patent laws adopted by all civilized nations in modern times.

To those who look only upon the surface of human affairs, the idea of nations devoting themselves to the production of these terrible weapons of war is shocking, but, as was said by a prominent writer:

> If the wealth of nations is based upon the industrial energies of their peoples, the power and independence of a nation is no less dependent upon a healthy condition of its military institutions and the excellence of the arms it places in the hands of its soldiers.

But recently one of Europe's greatest statesmen, himself a prominent military chieftain, has said that the terrible destructiveness of modern weapons and the enormous cost of war is becoming such that soon civilized nations could not afford to war with each other, thus confirming the statement that—

> There are no more eloquent pleaders in the cause of peace and arbitration than the destruction-dealing instruments that science has made for modern warfare, and this fact should cheer those who have that cause at heart.

While in the present state of society the good time coming may seem afar off, still every lover of his race will long and labor for the time when war shall be no more, and the rivalry between nations shall be in the effort to excel in the arts of peace, of which these international exhibitions are but an exemplification.

FIREARMS, AMMUNITION, ETC.

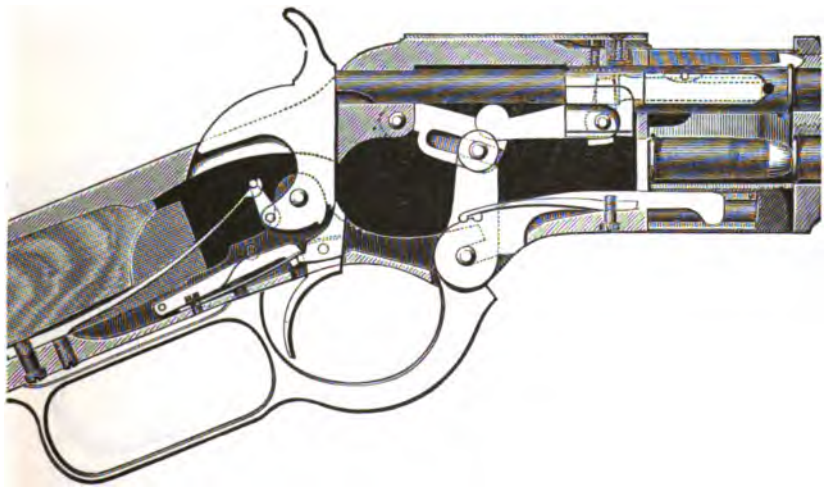
By W. C. Dodge.

AMERICAN EXHIBITS.

The development of the gun industry in the United States resulted in a large number of exhibits by Americans, mostly of sporting arms, ammunition, and gun implements, while there were comparatively few by foreign exhibitors.

THE WINCHESTER REPEATING ARMS COMPANY'S EXHIBIT.

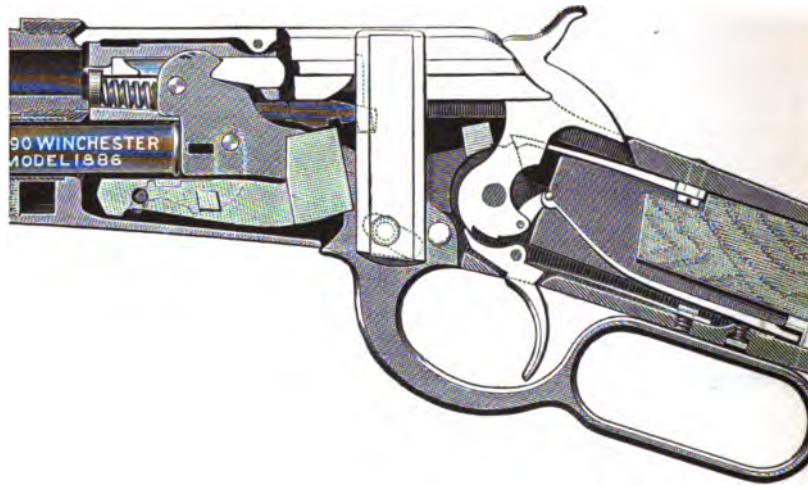
One of the largest and finest exhibits was that of the Winchester Repeating Arms Company, of New Haven, Conn., which embraced the well-known Winchester repeating gun, made both as a military and sporting arm. The following cut shows the form of the gun known as the model of 1873:



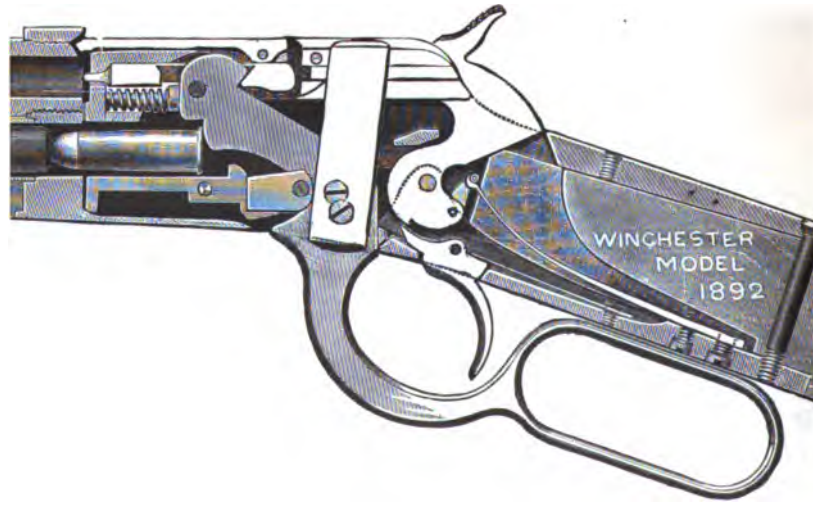
Another, known as the model of 1886, is shown in the accompanying illustration. In this, the reciprocating breechblock is locked in posi-

tion by a vertically reciprocating block, which renders it more secure and better adapted for firing heavier charges.

This was still further improved by their model of 1892, shown in the cut below.



Their exhibit also contained a single-shot rifle having a vertically reciprocating breechblock operated by the lever; a repeating rifle operated by a sliding movement of the left hand, and the Hotchkiss



repeating gun, designed more especially for military use. These arms are made in various styles and of various calibers, by which they are adapted to all the purposes for which a rifle can be desired.

In addition to these, they also exhibited a repeating shotgun firing

six charges, operated by a hand lever, and also a new magazine shotgun of what is termed the "trombone" style (from the fact that the gun is operated by a reciprocating movement of the left hand), and which is illustrated herewith, first in the closed and second in the open position.

A new feature of these arms is means for instantly detaching the barrel, so that they can be conveniently packed in a trunk or case.

All of these arms showed excellent workmanship, and some a high degree of ornamentation. The exhibit also contained a very extensive assortment of metallic cartridges, ranging from the smallest size made up to 8-inch shells for the rapid-fire guns recently introduced, and also

paper shells for shotguns, all of excellent quality. They also exhibited specimens of jacketed bullets, which were invented and first used by this company and which have recently been adopted for the small-caliber military arms now used by nearly all nations.

In connection with the above the exhibit also contained a variety of tools for reloading and recapping shells; one of which seemed to be especially useful, as in addition to removing the spent primer, inserting a new one, and reloading the shell, it also resizes the cartridge to fit the chamber of the gun, thus enabling the same shell to be used many times—a result of much importance to persons on the frontier or distant from the source of supply.

The manufacture of arms was begun by Governor Winchester in 1857, who subsequently organized the present company. Since the erection of their present works in 1870, the company has become the largest private manufacturer of arms in the United States at the present time. More than a million of their arms have been sold at home and abroad.

THE REMINGTON ARMS COMPANY'S EXHIBIT.

The exhibit made by the Remington Arms Company consisted mainly of the well-known Remington gun, in its various styles, as manufactured for home and foreign use. Its construction is so well known as to require no description further than to say that it is one of the simplest and best single-fire breech-loading guns ever produced, as is attested by the fact that since its introduction in 1865 about 1,600,000 of them have been sold at home and abroad, mostly for military use. They are also made for sporting purposes, and the long-range "Creedmore" target rifle, used in the international matches, established its reputation as equal to any in the world for fine shooting. The exhibit also contained samples of the double-barreled breech-loading shotguns made by the company, the manufacture of which they commenced about 1869. These guns are made in the ordinary style of breakdown guns, with rebounding locks, having outside hammers, with a firing pin in the breech shoulder. They are made with plain, homogeneous steel barrels, which this company first produced. These barrels are drawn out by rolls from a solid piece of steel, and being made throughout without any weld, they are exceptionally strong and free from defects. In shooting qualities some of these guns have proven equal to the high-priced foreign guns, though sold at a much less price. The exhibit also contained samples of the well-known Remington revolvers, so extensively used during our late war, they having since been adapted to the use of metallic cartridges. The article of most interest in this exhibit was, however, the Lee magazine gun, which has recently been adopted by the British Government for its army. This gun, which was patented at home and abroad in 1879, was the first of its kind. Its principal feature of novelty consists in the form and location of the magazine which contains the cartridges. This is made in the shape of a box in which the cartridges lie one upon another, with a spring at the bottom, which shoves the cartridges up as fast as they are used. It is located just in front of the trigger guard, with its open upper edge fitting in a slot cut through the bottom of the receiver or frame, so that as the bolt, in its forward movement, shoves the top cartridge forward into the chamber of the gun another takes its place ready for the next movement of the breech bolt. The box or magazine is made detachable,

the idea being to have a number of them ready filled, so that the soldier can remove the box when exhausted and replace it with another. It is provided with a "cut-off," or stop, by which the cartridges can be held in the magazine and the gun be used as a single loader.

This gun is shown in the accompanying illustrations.

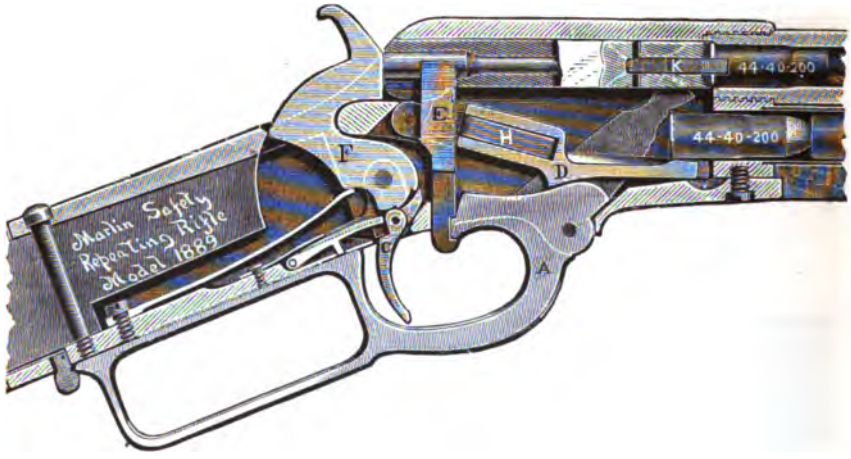
One great advantage claimed for this gun is that by locating the magazine at the center the balance of the arm is not changed, whether the magazine be full or empty.

This style of gun, modified in its details more or less, has been adopted by nearly all the European and several of the South American

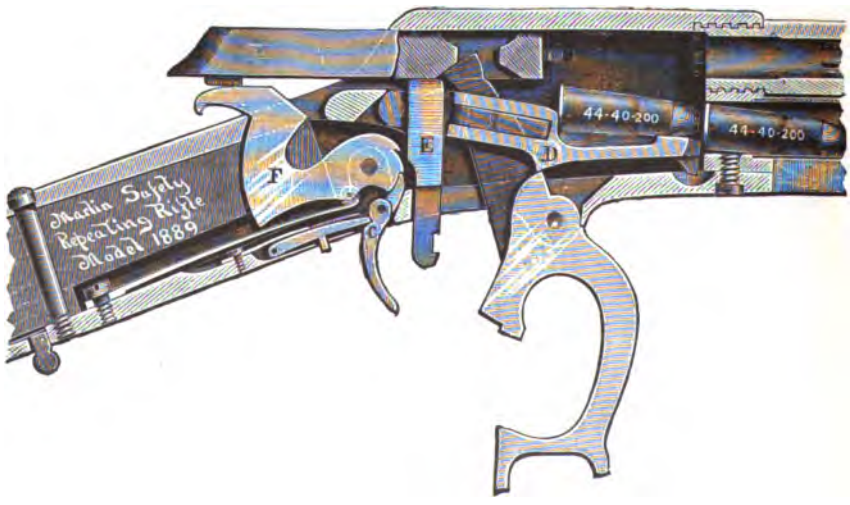
governments. In most of these modified guns a clip is used to hold the cartridges while being shoved into the magazine, or to hold them in the gun, in lieu of a separate box or magazine. This was also an American invention, having been devised and first used by Capt. A. H. Russell, of the United States Army, who also had three guns with his improvements on exhibition in the United States Government building. A large number of this class of guns were recently submitted to the board appointed to select a magazine gun for the United States Army, most of which were on exhibition in the United States Government building, and are described in the accompanying report of Captain Russell, who had charge of the same.

THE MARLIN FIREARMS COMPANY'S EXHIBIT.

The exhibit of the Marlin Firearms Company, of New Haven, Conn., consisted of a fine collection of repeating rifles, of two different styles of mechanism, both designed to be used either for military or



sporting purposes. In general appearance these guns resemble the well-known original Winchester, but differ therefrom in their operating breech mechanism, in which the reciprocating breech bolt is operated by direct connection with an arm of the lever, and is locked

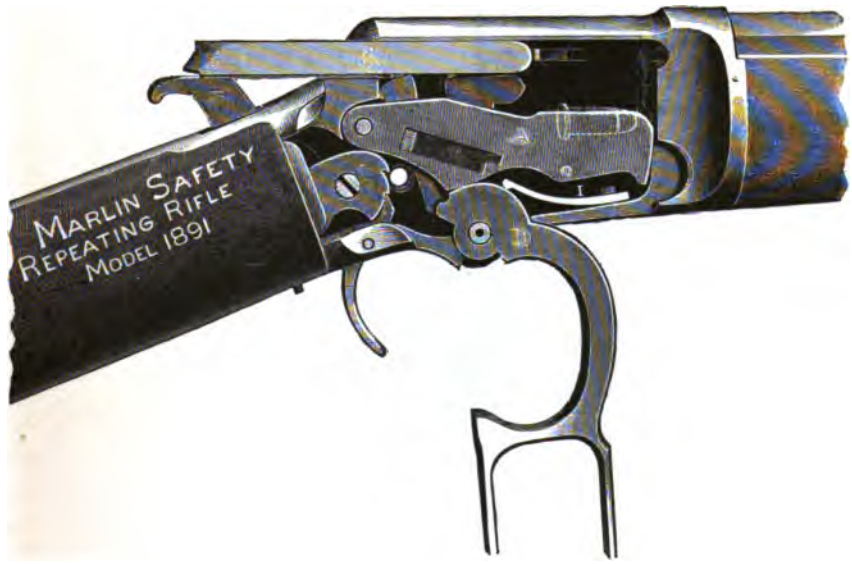


fast when closed by a vertically moving bolt or block, which, in turn, is operated by another arm of the same lever. The carrier which lifts the cartridges from the magazine to the chamber is operated by this same lever, and thus a single solid lever directly operates all the

parts, the mechanism as a whole exhibiting great ingenuity. Another feature of this arm is that the receiver or frame has the opening on its side instead of on the top, by which rain, dust, etc., is less liable to get into the operating mechanism. The accompanying illustrations show the mechanism both in the closed and open positions.

Their later gun differs from the former in the means for locking the breech piece closed, it being accomplished by the front end of the lever, which engages as a brace against a lug on the underside of the reciprocating breech piece when closed, and also in the means for operating the cartridge carrier. Its construction is shown in the illustration below.

The smaller of these guns was shown with the side plate of the frame removable by loosening a thumb nut, by which the mechanism is rendered accessible for cleaning, oiling, etc. Their barrels are also made detachable, which enables the guns to be conveniently packed in a trunk or case.



These arms are well made, of good material, and are largely used for hunting and sporting purposes, and to some extent as a military arm.

THE BURGESS GUN COMPANY'S EXHIBIT.

This company, located at Buffalo, N. Y., exhibited a gun of the "trombone" style, which is a new departure in that line. Instead of having the slide operated by the left hand, as in all others of this class, it is moved by the right hand. The trigger guard, with the trigger, is arranged to be moved back and forth by the right hand, with the finger ready to pull the trigger, the advantage of this arrangement

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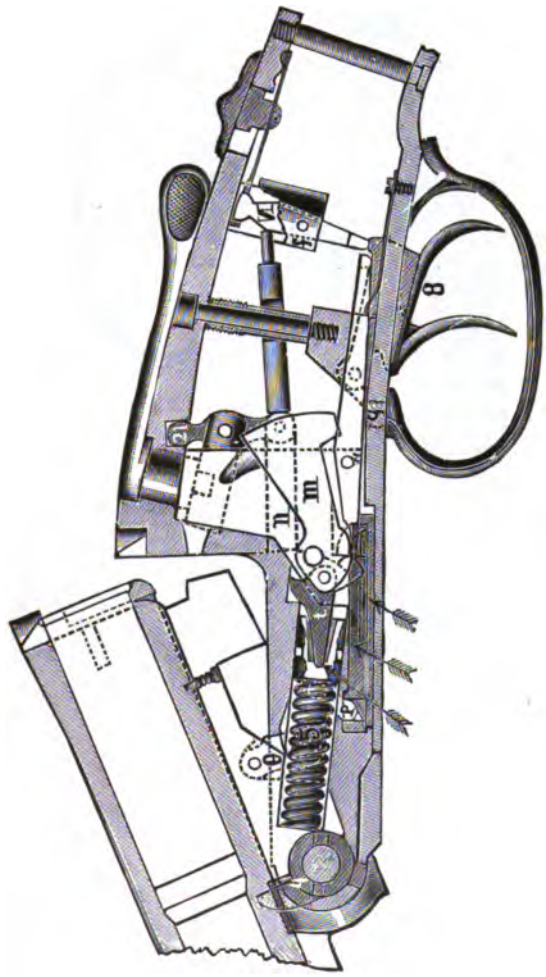
being that the aim is less liable to be disturbed, as the left hand, which holds the gun pressed against the shoulder, is not required to change its position in firing the six shots, and which can be done in three seconds. The breech mechanism is exceedingly simple and strong, consisting primarily of a horizontally reciprocating breechblock and a vibrating brace to lock it closed, and which is released by the backward movement of the trigger guard or handle, as it is termed, which also opens the breech, at the same time withdrawing the spent shell and lifting a fresh one from the magazine into position to be shoved into the chamber of the barrel, as is customary in magazine guns. It is provided with a safety device by which the breech is prevented from being opened until the previous charge has actually exploded, to prevent accidents in case of a hang fire, it being so arranged as to be thrown into the operative position by the recoil. It is also provided with two extractors, which grasp the cartridge on opposite sides, and, pulling straight back, render its extraction easy and certain. The barrel can be instantly detached by simply pressing a spring catch and slipping the barrel downward from the receiver. The guns exhibited were shotguns, but it is also made as a rifle, and of any caliber desired. It is shown in the accompanying illustrations (pp. 1112–1113), both in the closed and open positions.

THE PARKER GUN EXHIBIT.

This company, which was one of the first to engage in the manufacture of double-barreled breech-loading shotguns in the United States had a large number of its guns on exhibition of both the hammer and hammerless varieties, and of different qualities. The general appearance of their gun is shown in the accompanying cut.

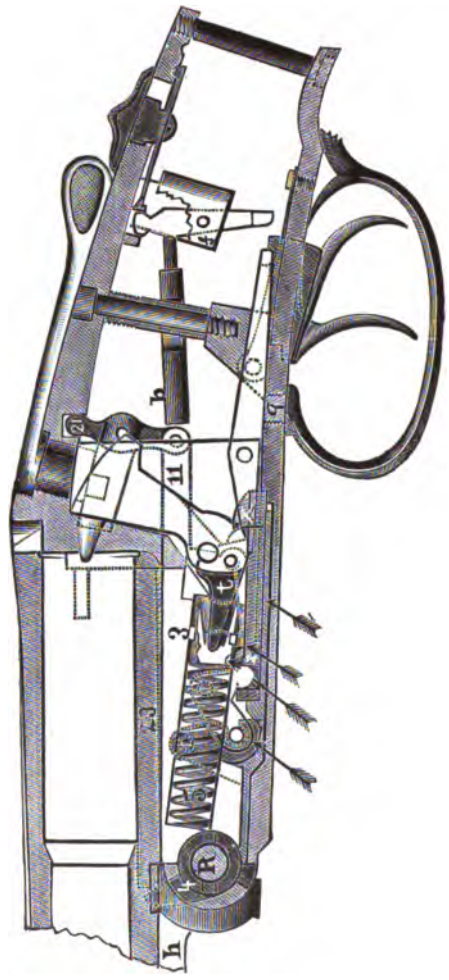
In the hammerless, the hammers are cocked automatically when the barrels are dropped, by means of a single slide in the lower part of the frame, operated by an elbow lever connected to the under side of the barrels by a pivoted link, the parts being so proportioned and adjusted as to work very smoothly and evenly.

A peculiar feature of this gun is that it has spiral mainsprings, which it was formerly thought would not be reliable in a gun, but which, as made and applied in this gun, has proven so reliable that the company guarantees them for twenty years. One of these springs was operated 1,200,000 times by mechanism arranged for the purpose and remained unbroken—a most remarkable test—and speaking volumes for the



quality of the steel and its tempering. The same spring, in connection with a patented device, also causes a rebound of the hammers in such a manner as to prevent the possibility of the point of the hammer resting on or sticking in the primer. The mechanism is shown in the accompanying sectional views. They are also provided with a "safety" to prevent accidental firing. The barrels are locked fast by a sliding bolt engaging with the lug under the barrels, operated by a

thumb lever on top and by an extension of the rib on the top of the barrels, having side projections fitting into a recess in the top of the breech frame. The finish and workmanship were very good, espe-

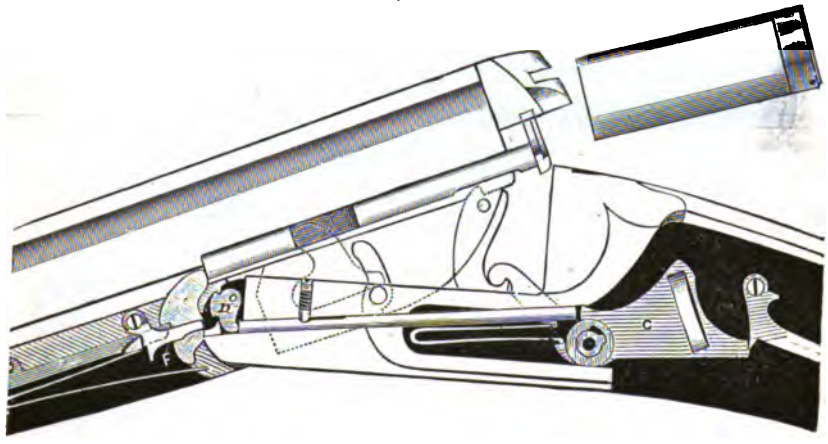


cially the close fitting of the parts, and altogether they were fine examples of American machine work. They have an established reputation among sportsmen and are largely used.

THE LE FEVER ARMS COMPANY'S EXHIBIT.

This company, located at Syracuse, N. Y., had a fine exhibit of their double-barreled shotguns of the break-down style. These are hammerless guns, automatic cocking, with a safety, and an indicator to show whether the hammer is cocked or down. They were the first in the United States to apply an automatic ejector of their own inven-

tion, which is located in the fore end and operates in a very efficient manner. The trigger pull can be regulated as desired, and provision is made for compensating for the wear of the parts so the barrel can



be kept tight on the frame. The locks are rebounding, and both are cocked by a single lever which engages with a hooked link pivoted to the under side of the barrels, which are locked by a self-compensating

bolt operated by a thumb lever on top. The mechanism and general appearance of the gun is shown in the accompanying illustrations. They have an established reputation for good shooting, and are a fine example of American machined guns.

THE SMITH & WESSON EXHIBIT.

This firm, located at Springfield, Mass., had an extensive exhibit of its specialty, the Smith & Wesson revolvers, of all sizes and styles. The arm is so extensively and well known that a detailed description is unnecessary, but it may be stated that the great number of inventions and improvements which they have added since they applied the Dodge extractor some years ago makes it to-day the most complete weapon of its kind in the world.

One of the latest and most important improvements is placing the hammer entirely within the frame and providing an automatic safety device which prevents the hammer from moving except when held in the firing position in the hand, thereby preventing the numerous acci-

dents arising from the carrying and careless handling of this class of arms. It is shown in the accompanying illustration with this improvement applied. The material used is of the best, and the workmanship, especially in the fine fitting of the machine-made joints, is believed to be equal if not superior to any in the world. They also showed a single barrel, with adjustable sights, which, by the removal of a screw, can be substituted for the rotating cylinder and barrel, thereby converting the arm into a target pistol.

A feature in this exhibit was the new designs and the high degree of ornamentation shown in some of the revolvers. Another feature of this exhibit which was highly instructive and attracted the attention of foreign visitors was a complete set of the several parts of the arm in all their stages, from the block of steel to the finished arm, and the gauges used to measure all the parts. A better illustration of the American system of manufacture by which the parts are made interchangeable, and showing the high degree to which machine work in this line has been brought in the United States, has probably never been made.

Among the exhibits of this firm was also a new style of self-lubricating bullet. It consists of a hollow bullet having several small lateral holes, through which the lubricant placed in the cavity is forced out by a plug in the rear part of the cavity by the explosion. This is

applicable to all arms which use bullets, and is considered an important improvement. Its structure will be readily understood by the illustration, which is a longitudinal section of a cartridge containing the self-lubricating bullet. A indicates the cavity for the lubricant, C the holes through which it is expelled, and B the plug which being forced forward by the explosion forces the lubricant out in advance of the point where the bullet has its bearing in the barrel.

COLT'S PATENT FIREARMS MANUFACTURING COMPANY.

The exhibit of this company consisted of a large case of rifles, shotguns, and revolvers. In the center of the case was a likeness of Colonel Colt, the founder of the company and inventor of the revolver which bears his name. Around this were arranged the large number of gold, silver, and bronze medals awarded these arms in various countries, and around these were grouped the finished arms, and also the forgings or the various parts, the whole forming a most instructive exhibit. This was rendered still more interesting and instructive by including samples of the various styles of revolvers made by the company from its beginning at Paterson, N. J., in 1833, down to the present time. The first was a .34 caliber known as the "Texas pistol," and which not unfrequently sold for $100 in those days. Then came the old model army revolver in 1847 of .44 caliber, and in 1848 the "Walker," named after a celebrated Texas ranger, also .44 caliber. In 1851 these were followed by the old Navy revolver of .36 caliber, and in 1855 by the new model Army, new model Navy, new model Police, and new model pocket revolvers. All these arms used loose powder and balls with caps. Then came the army model revolver of 1873, of .45 caliber, and using metalic cartridges. This arm was subsequently adopted by the United States Army ordnance board, who recommended it "as best adapted to meet all the requirements of the military service."

Their latest are the new United States Army model of 1889 and the new United States Army revolver of 1892. Both of these are double action, self-cocking, with a solid frame, and have the cylinder hung to swing out at the side, with an extractor operated by hand to simultaneously eject all the shells, as shown in the accompanying cut* (p. 1120).

The Navy revolver is .38 and the Army .36 caliber. In addition to these, the exhibit also contained various samples of double-action house and pocket revolvers, and also Derringer pistols.

*In justice to all concerned, it may be proper to state that in 1866 W. C. Dodge, of Washington, D. C., designed, had made, and submitted to the Chief of Ordnance this identical style of army revolver, the idea of the chief then being to convert the large number of Remington revolvers on hand at the close of the war to metallic cartridge revolvers and apply the Dodge extractor. This fact was unknown to the Colts Company, as nothing further was done by the Department for some time.

The company also exhibited an arm denominated the "lightning magazine rifle." This is of "trombone" style, the operations of loading, firing, and ejecting being all accomplished by the left hand moving a slide back and forward. These are made of various calibers, the .22 being much used in shooting galleries and for target practice. They also exhibited double-barreled hammerless guns, which, like all their other exhibits, showed good material and excellent workmanship.

In this connection, and especially in view of the fact that it has been claimed by foreign writers that there was nothing new in Colonel Colt's invention of the revolver, it may not be amiss to state just what he did invent. Revolving arms had before been devised in which the cylinder was turned by hand, another by a crank, another by the hammer as it fell to ignite the charge, and still another in which the cylinder was moved and the hammer cocked by mechanism operated by a second trigger; but none of these, for obvious reasons,

ever came into general use. Colonel Colt's invention was made while on a trip from Boston to Calcutta in 1830, and was patented in England in 1835 and in the United States in 1836. The distinguishing features of his invention were, first, providing the rear end of the cylinder with a ratchet and pivoting to the hammer a pawl so arranged as to engage with the ratchet and thus rotate the cylinder positively by the cocking of the hammer; and, second, providing a pivoted detent or catch so arranged as to drop into a recess in the cylinder and lock it fast when it had been turned to the exact position required and hold it there until fired, and which, at the first movement of the hammer in cocking, was instantly withdrawn, leaving the cylinder free to be rotated by the pawl during the further movement of the hammer in cocking. There were, of course, numerous minor features necessary to complete the operation of these parts, but these two features, which had never before been embodied in an arm, were what made it the great success that it has since proven to be.

SPENCER REPEATING SHOTGUN EXHIBIT.

The Spencer repeating shotgun, made at Brooklyn, N. Y., and exhibited by the Simmons Hardware Company, of St. Louis, Mo., is remarkable as being the original or first of what is termed the "trombone" style of gun. It is a magazine shotgun, the magazine tube extending about half the length of and underneath the barrel. On this is mounted a slide, which is connected with a vertically oscillating block which constitutes both the breechblock and cartridge carrier, so that a to-and-fro movement of the slide by the left hand operates the breechblock and carrier, this to-and-fro movement of the hand serving to place the cartridge in the chamber, close the breech, withdraw the empty shell, and, after the first discharge, to also automatically cock the hammer. It is capable of being fired six shots in three seconds, and is specially adapted for the use of prison watchmen, or the police or military, in case of riots, etc., but is also used for sporting purposes. It is also made with a 2-foot barrel and a sling, as a defense for travelers.

THE BROOKS ARMS AND TOOL COMPANY'S EXHIBIT.

This company, located at Portland, Me., exhibited a sample of its guns, which consist of three different styles—a single-barreled shotgun or rifle, a double-barreled shotgun, and a double-barreled shotgun having a rifle barrel above the shot barrels. These guns are all of the breakdown style, operated by a lever underneath, and are provided with an automatic extractor which ejects the shell when the barrels are dropped. The samples shown were handmade, simply to show their construction, the company having but recently commenced their manufacture.

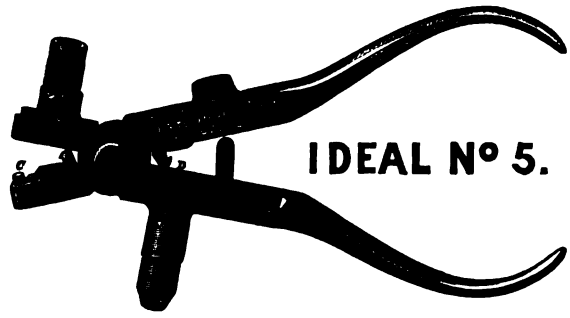
EXHIBIT OF THE IDEAL MANUFACTURING COMPANY.

This company, located at New Haven, Conn., made a fine exhibit of special implements or tools to be used in the preparation of ammuni-

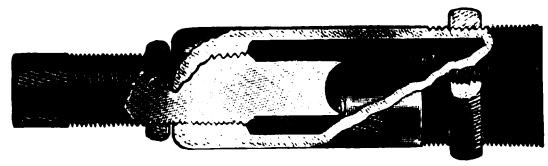
A, opening mouth of shell; B, bullet mold; C, recapping; D, loading chamber; E, bullet sizer.

tion for various styles of guns. The special feature of these implements is the combination in one of several different implements,

whereby a single implement is made to answer all the purposes required. For instance, their No. 4 tool comprises a bullet mold, a device for opening the mouth of shells that have previously been used and crimped

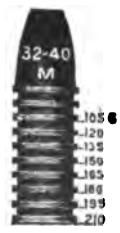


A, opening mouth of shell; B, resizing expanded shell; C, recapping; D, loading chamber; E, sizing bullet.



Double adjustable chamber. (Enlarged view.)

on the bullet, a decapping and recapping device, a bullet sizer, and a chamber for reloading the cartridge, the whole occupying but little more space than a pair of good sized pliers. This tool is shown in the illustration. Their No. 5 tool, designed especially for use in armories, omits the bullet mold, but has an adjustable resizing chamber for shells of different lengths, as shown below. It has also a double-adjustable chamber that can be substituted for the chamber B by means of which either round bullets, or elongated bullets of different lengths, can be properly seated in the shells. This tool with its double adjustable chamber is shown above.



Another convenient device was an adjustable mold for casting bullets of various lengths, as shown by the accompanying cut, which also shows samples of the bullets that can be cast in it.

They also exhibited a mold for casting the plain bullets of ten different lengths, such as are used with paper patches for target shooting. This mold, as shown in the cut, is made with a solid cylindrical body,

...are perfectly cylindrical, and without the fins pro-... mold. The bullets are pushed out endwise by the ...ich can be adjusted by the screws to form bullets of ...gth.

...nited a powder flask adapted to use either the com-...wders, it being graduated to measure from three to ...thirty-five grains, and from one-quarter of a drachm

...going are but samples of the great variety of implements ... and which, taken together, show a wonderful degree of ...and compactness, they being adapted to every conceivable ...hose using either sporting or military arms.

THE UNION METALLIC CARTRIDGE COMPANY'S EXHIBIT.

...company, located at Bridgeport, Conn., had a very extensive ...mplete exhibit of metallic cartridges, ranging from the smallest ...up to 4-inch solid-headed shells, for rapid-fire guns. They also ...ited paper shells for shotguns, and indeed everything in the line ...repared ammunition. Being the first to engage in the business on ...rge scale in 1864, their goods are so extensively used at home and ...oad, and consequently so well known, as to require no special ...scription.

THE BRIDGEPORT GUN IMPLEMENT COMPANY.

This company makes a specialty of implements for use in connection with firearms, including implements for reloading and recapping cartridge shells of all varieties, implements for cleaning guns, whistles, calls, and also gun and implement cases in great variety. In short, the exhibit contained everything of the kind for which the sportsman has use, and altogether was probably the most extensive and varied exhibit of the kind ever made. This company also manufactures and exhibited a remarkably useful tool, known as the Forstner auger bit, which is not only capable of boring round, square, and oval holes, but by which spiral rods can also be formed, and other ornamental effects

produced, as was well illustrated by the ornamental work on the case containing the exhibits. One of the peculiarities of this bit is that instead of being guided by its center, as most boring tools are, it is guided by its periphery, and hence while operating can be made to move laterally in any direction desired, thereby producing effects which to the ordinary observer would seem impossible with so simple a tool.

FOREIGN EXHIBITS.

The foreign exhibitors in group 113 were much less numerous than were the American exhibitors. The British exhibitors especially were all old-established manufacturers, whose guns have long been on the market and are well known. They, however, contained many features that are comparatively new, and all were of excellent material and workmanship, more especially in their ornamentation, some being most elaborately engraved. They differ from the American guns in that, with the exception of a little machine work on the breech frame and the barrels, they are wholly hand made, and consequently are expensive, whereas the American guns are made almost entirely by machinery, which enables them to be sold much cheaper and in much larger quantities.

The idea so long prevalent that close-fitting joints can not be made by machinery was demonstrated to be an error by many if not all of the American exhibits in firearms. To show how finely fitted the joints of the working parts were, a pencil mark was made on some of the parts, and so close was the fit that a single movement of the barrels completely removed it; and this was a gun taken from the regular stock, and not one specially prepared for exhibition.

W. W. GREENER'S EXHIBIT.

Mr. Greener, whose factory is at Birmingham, England, and who succeeded his father in the manufacture of guns, had a large assortment of both shotguns and rifles. Among these were double-barreled shotguns of the breakdown variety, hammerless, and with automatic ejectors, which he was the first to adopt. Others of the ordinary style with outside hammers were also exhibited, both of these styles being shown in great variety of finish and prices. One feature on which stress is laid consists in having a projection on the rear end of the barrels fitting into a recess in the breech shoulder or frame, with a bolt moving at right angles and locking in a hole in the projection, in addition to the usual lug under the barrels, whereby the barrels are so firmly locked to the breech as to prevent any spring of the barrels at the breech and consequent droop at the muzzle at the instant of discharge.

In the Greener shotguns the mechanism for operating the ejectors is connected with the gun locks, and is operated by the main springs of

the latter. These guns are also provided with a "safety" to prevent their being fired accidentally, a feature now used in nearly all guns which have their hammers concealed.

The exhibit also contained rifles made on the breakdown plan, both single and double barreled, some with automatic ejectors. Many of these guns were designed for large game, such as elephants, tigers, etc., while there were others of small bore, designed for shooting rabbits and other small game.

The exhibit also contained two and four barreled pistols, smooth-bore, of large caliber, and having the Dodge or American extractor applied. In these the barrels are hinged at their lower rear end to the frame, and are held by a spring catch provided with a thumb lever for releasing the barrels. These four-barreled pistols have a separate striker and spring for each barrel, with a single trigger and a vertical spring with projecting studs so arranged that by pulling the trigger the strikers are cocked and fired in rotation.

This exhibit was especially good in an instructive point of view, as it contained samples of the iron and steel used for gun barrels in all its stages, complete sets of gun actions and lock mechanisms used in the modern hammer, hammerless, and ejector guns, from the rough forgings to the finished articles; section of barrel showing the Greener choke bore; a case containing various specimens of locks for hammer guns; working model showing the action of the parts composing the automatic ejector; wooden models of hammerless guns, illustrating their action; complete set of the parts of the Martini rifle and model of the finished action; model of the Mauser action or gun action of the Lee-Speed gun, and numerous sections of barrels illustrating various styles of rifling, varying from two and one-half to seven thousandths of an inch in depth. Altogether it was a very complete exhibit.

THE LANCASTER EXHIBIT.

This concern is also of long standing, having been established in 1826. It is located in London, England, and the Lancaster rifle is known far and wide because of the peculiar form of its bore, which is oval in cross section. The exhibit contained a great variety of guns, including a fine assortment of double-barreled breech-loading shot-guns of the breakdown style. These latter are made in various styles, the principal ones being hammerless, self-cocking, both with and without automatic ejectors, the latter being located in the fore end of the stock, in front of the hinge joint. Others were made with outside hammers, and both with a slide or bolt engaging with two lugs which lock the barrels to the frame below, the locking bolt being operated by the usual top lever. They were also provided with a "safety" to prevent accidental firing.

The exhibit also contained a fine assortment of single and double

rifles of all sizes, from the large bore for hunting elephants, tigers, and other large game, to the smallest for small game—rooks, rabbits, and the like. Some were made with the top lever and automatic ejectors and others with the locking lever underneath the trigger guard and arranged to swing laterally, like the original Lafaucheux French gun.

This exhibit also contained a four-barreled gun, with concealed firing mechanism, so arranged that when two barrels had been fired the movement of a lever set the mechanism to fire the remaining two. It was a smoothbore, designed to fire either bullets or shot. There were also samples of two and four-barreled hammerless pistols, smoothbore, of large size, using metallic cartridges, and designed as a substitute for the revolver, especially in hunting the large game of India and other eastern countries. The lock work in these is similar to that of the four-barreled gun mentioned above, but which, in the absence of any illustration, can not be clearly described.

This exhibit also contained a variety of gun cases, cartridge holders, and similar articles for sportsmen's use, which were made of the best material and very strong and durable.

With this exhibit there was also shown a lot of revolvers made by Webley, but as they were of the ordinary style, and had nothing peculiar except the American or Dodge extractor, they require no special description.

SCOTT & SONS' EXHIBIT.

This well-known firm of London, England, had a fine exhibit of the double-barreled shotguns, for which they have long been celebrated. These guns were exhibited in various styles, the latest being of the hammerless variety, automatic cocking, and with automatic ejectors, the operating mechanism of which is located in the foreend. They are also provided with a "safety," to prevent accidental firing. These, like the Greener guns, have a cross bolt for locking the barrel extension to the breech frame, and in the better class this bolt is rectangular instead of round, and fitted to work with great accuracy. Others were shown with outside hammers, and some with ejectors operated by the mainsprings of the locks.

The catalogue of their exhibit described no less than 35 different guns made by this firm, the difference, however, in some cases consisting only in the difference in the stock, bore, and finish. The elaborateness with which some were ornamented by hand engraving was remarkable, while the material and workmanship were unexcelled.

RUSSIAN EXHIBITS.

The Fuse Instrumental Works of St. Petersburg, Russia, had four exhibits classed in group 113, which consisted of a variety of instru-

ments designed for use in connection with the manufacture of artillery and munitions of war. One of these was an universal instrument for measuring the bores and chambers of guns, 35 calibers long, and from 6 to 12 inches caliber. In general terms, it consists of a tube having an interior tubular rod which moves an interior wedge or cone, which, as it is moved, forces outward a series of lateral rods or spires, the ends of which touch the walls of the bore. The uniform pressure of the spires or measuring parts is attained by means of a spring. For counting off the divisions, the handle is supplied with a small scale, the vernier of which gives one six hundred and twenty-fifth of an inch, and, at the falling of the rod, which is 0.05 inch by 1 inch long, the degree of the exact measure will be expressed by the figures one six thousand two hundred and fiftieth of an inch. The length of the implement, which is made in sections to screw together, is 38.5 feet, and on the exterior tube are divisions up to 360 inches.

The second exhibit, termed Mechanic Brauer's optic instrument, is for measuring the chambers of 9 and 11 inch guns. It is provided at one end with three spires, two for measuring horizontally or laterally, and the third for centering. On the side of the head, facing the observer, is a scale and vernier lighted with an electric lamp with a reflector. At the outer end of the instrument is a telescope for counting the divisions on the scale, which are 0.0001 of an inch. The centering spire is movable, for which purpose it is supplied with a pinion engaging in a steel rack passing along the instrument to its opposite end. The measuring spires are regulated by a spring, while the pressure of the centering spire is secured by a counterweight attached to the head of the instrument. By means of this instrument one is enabled to find in every vertical section of the gun the largest dimension or diameter.

The third exhibit comprised a series of instruments for verifying the various dimensions of shells for field guns, and others for testing and verifying the dimensions of cases for shrapnel. The fourth was a spherometer, or instrument for finding and measuring any unevenness on plane surfaces, the curvature of surfaces, etc., adjusted to read to the ten-thousandth of an inch.

These instruments have been adopted by the Russian authorities, and, altogether, form an interesting exhibit.

GOVERNMENT EXHIBIT OF GUNS AND AMMUNITION.

By Capt. Andrew H. Russell, *United States Army.*

Introduction.

Scope and arrangement of ordnance exhibit.

The model for an ordnance exhibit was established by Capt. Henry Metcalfe, of the Ordnance Department, in the remarkable display made under his supervision at the Centennial Exposition in Philadelphia in 1876. The lines there laid down were believed to be the best possible, and no marked departure from them was made in arranging the present exhibit. The only difference consists in the introduction of many new and important machines and devices that have come up since that time, and in some modification in the order and classification in the catalogue, to adapt it to the new requirements arising from the increased importance given at the present day to certain classes of arms. Descriptions of many instruments and most of the earlier cannon, machine guns, and small arms have been taken from Captain Metcalfe's catalogue or condensed from descriptions given there.

The development of heavy guns now requires a more marked distinction between the new types and the old. Machine guns have been placed in a separate class, as new forms have been introduced. The rapid-fire guns are a new development in war, demanding separate treatment. In small arms the increased importance of magazine guns requires for them a separate classification with several subdivisions, their arrangement depending more on the peculiarities of the magazine than on the special features of the breech mechanism. In general arrangement of the catalogue the same system has been followed as was adopted in the report on the War Department exhibit at the exposition in Cincinnati in 1888.

In the classification of firearms an attempt has been made to show as far as possible the historic development from the earliest period, and to give the latest improvements, whether American or foreign. In the class of hand firearms the collection is particularly full, especially in relation to the latest magazine guns. Among cannon, specimens of almost the earliest make are to be seen. A very full exhibit of small-arm cartridges is made. Examples of range finders and testing instruments are given. Many relics of the Revolution, Mexican

war, and the war of the rebellion are exhibited. In a special shooting gallery many ballistic instruments are shown, operated practically, for determining the velocity of projectiles.

It is worthy to note that in recent years the greatest improvement in military weapons has been due to American inventors, but that the advantage of the inventions has been chiefly developed by foreign nations from the want of public interest in this country. This is true of powder, shot, cannon, machine guns, and small arms, and many things of American invention now used in our service have been reimported—for example, Rodman's perforated cake powder, the slotted breech screw for large guns, etc.

In regard to firearms, the very remarkable point is illustrated that the earliest cannon made were breechloaders, and that all nations have returned to this principle after long abandonment of it and use of muzzle-loaders. The collection of hand firearms comprises nearly 150 varieties. It is shown that some very early forms were breechloaders, but that it was only by the American development of metallic shell ammunition that breechloaders, now general, became efficient. Magazine guns were also made practicable by the above improvement in cartridges, and the first effective guns of this class, the "Henry" and "Spencer," used in the war of the rebellion, were American inventions. The more recent forms of magazine gun adopted by foreign powers, those fitted with detachable magazines or with fixed magazines made to fill rapidly by prepared packages, also owe their inception to American inventors. In machine guns the influence of American invention is very prominent, and automatic recoil guns were invented here, though developed abroad. The history of small firearms in the last two centuries shows a decrease of caliber from 0.81 inch to 0.25 inch, or even less.

As at the Centennial Exposition, an exhibit is made of the characteristic practical operations of cartridge making as conducted at Frankford Arsenal, and of the manufacture of the rifled musket as carried on at Springfield Armory. These branches acquire a new interest from the recent adoption of a magazine gun of small caliber. Some of the operations connected with the new manufacture are shown, though most of the machines are necessarily adapted to the old type of Springfield breechloader.

One valuable addition to the exhibit consists in the display of testing machines in actual operation, illustrating the methods used by the Ordnance Department at Watertown Arsenal for the mechanical test of materials for building purposes and for ordnance construction.

The ordnance section is shown on the accompanying plan in the central and northeastern parts of the exhibit of the War Department which occupied the southeastern corner of the Government building. Outside the building, along the east or lake front, are placed a 10-inch

steel rifle, two 12-inch breech-loading mortars, an 8-inch converted rifle, and a few siege and field pieces. Flanking the eastern doorway of the building are old muzzle-loading bronze mortars. Passing into the building by this doorway, the entrance to the ordnance exhibit appears on the left hand, an 8-inch breech-loading steel rifle, mounted on its carriage, in the middle of the aisle, forming the central object in view. Passing down the aisle, the shooting gallery comes first on the left, and on the right side the field gun and carriage are placed, with horses, showing the harness. Farther down the aisle, on either side of the 8-inch rifle, various machine guns are shown, and still farther on are placed the testing machines. On the right of the aisle, beyond the machine guns, is placed the 12-inch breech-loading steel rifle, and on line with it are found rapid-fire guns and the field mortar. Directly in front of the 8-inch rifle are placed the ancient cannon. Beyond the testing machines are the machines from Springfield Armory and Frankford Arsenal, and farther on to the left is the exhibit of small arms.

PREPARATION AND MANAGEMENT OF EXHIBIT.

In the arrangement of the arms in the exhibit effort was made to so place them that the separate classes could be easily picked out by the visitor, and the guns examined or even handled under the superintendence of men specially detailed for that purpose. Throughout the exhibit every effort was made to give all facilities to visitors to see the actual operation, not only of the machines displayed, but of the machine guns and larger breech-loading guns in the collection.

The main difficulties encountered in the installation of the exhibit arose from the short time allowed for preparation. My assignment to this duty was made July 19, 1892, less than ten months before the opening of the Exposition. This made it impossible to arrange for the delivery of the heavy guns and carriages before winter set in, and many of them had to be put in place outside the building in very inclement weather. The difficulties were also increased by the want of continuous expert assistance. Two officers of ability and experience were at different times assigned temporarily to duty with the exhibit as assistants, but were soon relieved. Capt. H. D. Borup reported January 11, 1893, but he was relieved March 1, just as shipments were beginning to arrive for installation. Lieut. Charles B. Wheeler, Ordnance Department, reported April 21, 1893, ten days before the Exposition opened, and he was relieved July 1. His assistance was invaluable. His practical experience in mounting heavy guns and carriages made him a most efficient assistant during the installation, and his services were of the greatest value in the early part of the Exposition. During my absence on sick leave, from July 24 to August 24, Capt. Frank Heath, of the Ordnance Department, took charge of the exhibit.

In the preparation of exhibits thanks are particularly due to the commanding officers of Springfield Armory, Sandy Hook proving ground, Watertown Arsenal, and Frankford Arsenal for responding so cordially to the hurried demands made upon them. Acknowledgments are due to the superintendent of the United States Military Academy and to the instructor of ordnance and gunnery there for furnishing many interesting articles for the exhibit; also to the commanding officer of Fort Monroe for contributions from the Artillery School. Every effort was made to have the exhibit on time and up to date, and the opening of the Exposition found it ready.

In the early days of the installation a valuable assistant was found in Sergt. Joseph W. Warwick, Ordnance Department, who was sent here from Sandy Hook proving ground to assist in mounting the heavy ordnance. He was killed April 17, 1893, by the slipping of a mortar carriage on which he was working. His loss was greatly deplored. At the close of the Exposition Sergt. Robert Johnston, Ordnance Department, was sent out from Sandy Hook proving ground to superintend the dismounting of guns and carriages and their loading upon cars for transportation. He conducted this work with marked ability and dispatch.

The greatest difficulty encountered in transferring articles to and from the exhibit occurred in the transportation of the 12-inch rifle and the spring-return carriage for the 12-inch mortar. For the 12-inch rifle, weighing 52 tons, it was necessary to obtain the car built by the Pennsylvania Railway for transporting one of Krupp's guns to the exhibit; and in returning the gun the same car had to be used to transfer it over the bridge across the lagoon which separates from the mainland the island on which the Government building stands. It was then transferred to another car for shipment to its destination. Thanks are due to Messrs. Gilhausen, Lauter, and Von Drebber, the representatives of the Krupp exhibit, for allowing this car to be used, as well as for many friendly attentions. A track laid through the War Department space assisted materially in bringing the 12-inch rifle into the building. Every preparation was made by Sergeant Warwick for its reception, to avoid detention of the car, and the trestles of the Laidley gun lift were placed across the track so that the car containing the gun was run directly under them. The car was detained but two hours. The gun was then lowered and swung round across the track. Besides the 11-inch rifle, for which no carriage was provided, an 8-inch breech-loading steel rifle, mounted on its carriage, was placed inside the building; the other large cannon—12-inch rifle, 8-inch muzzle-loading converted rifle, and 12-inch breech-loading rifled mortars—being placed outside along the front of the building.

The foundation of the spring-return carriage consists of two large rings, 14 feet in diameter, which had to be brought out on edge, on a

special car which allowed the rings to sink nearly to the track. At the time of installation there was but one car of this nature to be found. This was engaged in shipping mortar carriages from Alliance, Ohio, and it was obtained through the courtesy of the Morgan Engineering Company, which had charge of the manufacture of some of these carriages. As, however, the car could carry but one ring at a time, it had to make two special trips to Jersey City, so that the base plate for this carriage was not received until April 18, 1893. The whole carriage was set up and the mortar was mounted on it by May 1, the opening day of the Exposition. In returning this carriage a car was furnished which would take both rings at once, and by that time a special derrick had been obtained by which the handling could be done with greater facility. Proper machinery for handling heavy ordnance was lacking when the guns and carriages arrived.

In breaking up the exhibit the early snows in November interfered seriously with the work.

In the conduct of the exhibit most efficient assistance was received from Mr. C. S. Rogers, superintendent of the machines from Springfield Armory; Mr. J. S. Gilmore, superintendent of the machinery from Frankford Arsenal; Mr. James E. Howard, from the department of tests, at Watertown Arsenal; Mr. G. B. Preston, and Mr. H. H. Tracy, in charge of the testing machines. As general assistant in the superintendence of the exhibit Mr. Edward Schlesinger, of Cincinnati, performed valuable services, and Mr. Paul W. England, in general charge of the office work, and expert in the electrical department, proved a valuable assistant.

CANNON OF THE PAST.

This collection serves to indicate the progress made in the construction of cannon from the earliest forms—breech-loading smooth-bore guns of light weight, of date of the fourteenth century—to the rifle guns of to-day, which appear under the next heading. The forms of field-gun carriage illustrate the progression of construction from the Gribeauval system, used in the Napoleonic wars, and the stock trail system (wooden carriage), used during the rebellion, to the steel gun carriage now used.

EARLY CANNON.

1. Chinese cannon, bronze, breech-loader, fourteenth century.—This gun was captured from the Koreans, June 10–11, 1871, by the United States naval squadron, commanded by Rear-Admiral John Rodgers, United States Navy. Presented to the museum of the Artillery School, United States Army, by Maj. W. F. Randolph, Third Artillery. The charge was contained in a hollow block, with a handle at the top, by which it was placed in position. This breechblock had projections at the lower part of the rear end, and these, with the assistance of a

key driven above them, through mortises in the side of the breech, held the block in place for firing. The early guns in Europe were made of wrought iron, like the next gun described, and cast guns were unknown until 1378. This gun was contributed to the exhibit from the Artillery School, through the courtesy of Col. Royal T. Frank, commanding Fort Monroe. Other such guns, belonging to the same capture, are at the United States Naval Academy, Annapolis. (For an extended notice of these guns, see Proceedings of United States Naval Institute, 1892, Vol. XVIII, No. 2.) This gun is supposed to be the oldest of all. It is a bronze wall piece, with a caliber of 1.44 inches. The barrel is 18.62 inches long, and the breech-loading cavity 10.04 inches. Upon one side of the barrel is an inscription composed of fifty-one Chinese characters of an ancient style. This inscription gives the name of the official superintending the casting, of the officer of the artillery department, of the district magistrate, and of the smith who manufactured the gun, together with its official designation, "4th class fu ran chi, number 194," and its weight, 100 catties, or about 133 pounds. The date is inscribed as the kwei ch'au year, but as the characters kwei ch'au only indicate a particular year, the fiftieth, of the cycle of sixty years, and no regnal period is given, they are not sufficient to fix the age of the piece. The Chinese minister, in a communication to Secretary Bayard under date of July 26, 1886, states that the titles of the military officials upon the casting are those created during the Yuen dynasty, during which the year indicated by the cyclical characters corresponded with A. D. 1312.

Mr. Stewart Culin, of Philadelphia, states that the characters fu ran chi on the breech simply designated it as a Frangee, or Frank gun, and that the titles of the military officials of the Yuen dynasty, upon which the opinion as to its remote antiquity was based, are still used, on the eminent authority of Mr. Satow, in Korea, where the gun was captured. These facts, with those already elicited, were considered by Mr. Culin to establish a comparatively modern period for the gun. He also states that the Chinese encyclopedia refers to such guns as of late introduction, and he mentions that many such guns are in the naval museum at Madrid. It is to be noted, however, that in the museum at Darmstadt there is a Chinese bronze loading block of the year 1340, apparently made for use in such a gun; and foreign authorities refer to the early use of guns in China. Several guns shown in the Korean exhibit are represented as also about five centuries old. The two larger ones are of coiled bronze, and the spiral junction of the surface is evident outside and in. The smaller piece, a species of bombard, is of wrought iron. These guns are muzzle-loaders.

2. Old breech-loading gun, 4-pounder, wrought iron, similar form, found in the Hudson River.—Brought up by a dredging machine from the bed of the Hudson River, at Albany, in 1879. Though the date of the manufacture of this piece is not known, its form is precisely that

of the earliest English cannon of the fourteenth century, and similar guns were used by Columbus in 1492. It is made of wrought iron with projecting bands around the barrel. It has a short handle extending to the rear from the cascabel. The bore runs from a caliber of 2 inches at the breech to 4 inches at the muzzle. The exterior increases in diameter toward the muzzle, but the iron is so badly rusted that the original dimensions can hardly be determined. The breech-closing arrangements, which are lacking, were evidently the same as in the Chinese gun described above. This gun, with many other articles mentioned below, was sent from the museum of the Military Service Institution at Governors Island, through the courtesy of Maj. W. L. Haskin, First Artillery. A similar gun shown in the East India exhibit has the movable loading chamber complete.

CANNON OF THE REVOLUTION, MUZZLE-LOADING.

3. Small brass howitzer, American, caliber 2¼ inches.—This gun bears the inscription, "D. King, Germantown." From West Point.

4. French 6-pounder bronze gun, presented by General Lafayette.—The ornamentation of this gun is very elaborate and amply repays examination. From West Point.

5. English cannon, 12-pounder, bronze.—This piece was taken by General Lafayette in person at the storming of a redoubt at Yorktown, in which battle he bore a conspicuous part. When the General was on his tour through the United States in 1825 he called to visit the Watervliet Arsenal, West Troy, N. Y., and while the salute was being fired he recognized this cannon by a conspicuous indentation made by a shot in its side. He is said to have approached and embraced it as the companion of his youth. At the death of Lafayette the Government order was received at Watervliet Arsenal directing the half-hour gun to be fired in his honor. The order was executed with this same gun, which had been so prominently identified with his early history.

6. English fieldpiece, flintlock, bronze, caliber 3 inches, from Frankford Arsenal.—The gun is a smooth-bore muzzle-loader. The flintlock mechanism is carried by a bronze plate screwed to the breech of the gun with four large screws. To this plate is attached, also, a handle projecting to the rear, for use in sighting and pointing the piece. The flintlock is horizontally placed across the face of the breech. The flint hammer turns to the left and the powder pan is centrally placed on the gun. The piece is fired from the left-hand side by a trigger operated by a lanyard. Length, 3 feet 5½ inches.

CANNON OF THE MEXICAN WAR.

7. United States 6-pounder bronze gun, caliber 3.67 inches, Duncan's Battery.—This gun is marked "Palo Alto, Resaca, Monterey, Molino, Churubusco, Mexico." From United States Military Academy.

8. United States 6-pounder bronze gun, caliber 3.67 inches, Ringgold's Battery.—This gun is marked "Palo Alto, Resaca, Monterey, Buena Vista."

The above guns were used by United States troops during the Mexican war. For further notice of these batteries see "Carriage wheel of Duncan's Battery," among "Relics." These guns are shown in the side view of the shooting gallery. From United States Military Academy.

9. Mexican 17-inch bronze mortar, on bed.—This piece was surrendered by the Mexicans at Perote, April 20, 1847. It is of irregular form on the exterior, highly ornamented, and it has a handle running crosswise on top. It is a chambered piece, and its trunnions are at the rear, instead of being placed at the sides as in the mortars of the time of the rebellion. The mortar bed is a solid block of cast iron, and the piece is held at the desired angle by a wedge, or "quoin," placed under the muzzle.

10. United States 16-inch bronze mortar, on bed.—This represents the type of mortars used by us during the Mexican war. This piece, like the Mexican mortar, has a small powder-chamber in the bottom of the bore, and its trunnions are also in rear, the quoin being used for elevation; but it is nearly cylindrical in exterior form, with but two fillets and no ornamentation. It has one handle set crosswise on the top. The mortar bed is of iron, with cheek pieces bolted together.

11. United States 12-pounder bronze field gun, heavy, with handles, caliber 4.62 inches.—This piece is one of the heavy 12-pounders formerly used in our service. It is of plain exterior, with a few fillets, and with two longitudinal handles side by side on top. The Napoleon gun described below took the place of this piece and of the 6-pounder gun just described. Representations of this gun appear in views of projectiles and of the north entrance to the ordnance exhibit.

12. Model of 6-pounder gun on Gribeauval carriage.—This represents a light field piece used in the United States service before the war of the rebellion. At the commencement of the late war this piece was practically set aside with the heavy 12-pounder described below, and replaced by the light 12-pounder smooth bore, called the Napoleon gun. The carriage is a representative of the type of carriage introduced into the French service by General Gribeauval, and generally used for all field guns until 1827. It was a wooden carriage, made with two cheeks extending to the rear to form the trail, and united by transoms and bolts. It was replaced by the stock-trail system, also of wood, in which the stock of the trail was of solid timber, carrying at its front end cheek pieces bolted on each side, to hold the trunnion beds in which the gun was supported. The new steel carriage for the field guns is made more in the style of the Gribeauval than of the stock-trail system, the sides being continuous and separated by transoms.

CANNON OF THE WAR OF THE REBELLION.

13. Four-pounder muzzle-loading gun, fired first shot of the rebellion.—This gun fired the first shot in the cause of the rebellion. It was fired at a steamer passing Vicksburg for New Orleans, supposed to have on board ammunition belonging to the United States. This occurred before the attack on Fort Sumter. The authenticity of this occurrence was confirmed by an eyewitness who visited the exhibit. The following letter gives the record of this gun.

HEADQUARTERS DEPARTMENT OF THE MISSISSIPPI,
Vicksburg, Miss., July 5, 1866.

Hon. EDWIN M. STANTON,
Secretary of War:

I have the honor, in compliance with authority from you of May 16, to forward in charge of a detachment of the Fifteenth United States Infantry a small 4-pounder cannon, formerly the property of the city of Vicksburg, with the following history of the gun as furnished to me by a citizen of Vicksburg, Miss.:

"This was the first gun fired in the cause of the rebellion. I fired it myself at the steamer passing Vicksburg bound for New Orleans, supposed to have arms and ammunition on board belonging to the United States. This firing took place several days before any guns were fired at the United States forts or troops either at Charleston or Pensacola."

I have the honor to request that it may be placed among the relics of the rebellion preserved at Washington.

I have the honor to be, respectfully, your obedient servant,

TH. J. WOOD,
Major-General Volunteers, Commanding.

The gun was presented to the Military Academy, West Point, N. Y., July, 1873.

14. Three-inch wrought-iron rifle, muzzle-loader.—The piece exhibited here fired the last shot against Lee's army at Appomattox. It was at this time the left piece in Elder's Battery B of the First United States Artillery. This is a type of the gun used extensively during the war, and it was one of the earliest of modern wrought-iron guns. These guns were made at Phoenixville, Pa., by wrapping boiler plate around an iron bar so as to form a cylindrical mass. The whole was brought to welding heat in a furnace, and then passed between rollers to unite the bar and layers solidly together. The trunnions were then welded on, and the piece finish to the proper size. The bar forming the core is large enough to leave some metal outside the bore and add longitudinal strength to the gun. It fired a 10-pound shell. This gun was too small in caliber, and it took too light a charge for the best effect. The adoption of a larger caliber for rifled guns was urged by Colonel Laidley early in the war. Rifled guns for field service are now made of larger caliber. Loaned to United States Military Academy.

15. United States 12-pounder Napoleon gun and 24-pounder howitzer.—Model with carriage and limber. This illustrates the stock trail

system of wooden gun carriage, used during the war of the rebellion. The 12-pounder gun was adopted in 1856, and modeled after the gun designed by Napoleon III to take the place of the variety of calibers used before in the French field service. It was used more extensively than any other field gun during the war of the rebellion, and it was particularly effective where the character of the country required the fighting to be carried on at short range. Weight of gun, 1,226 pounds; weight of shot, 12 pounds; weight of charge, 2¼ pounds; velocity, 1,495 feet per second; extreme range, 2,090 yards; elevation, 10 degrees; weight of carriage, 1,175 pounds. Contents of chest, packed: shot, fixed, 20; spherical case, 8; canister, 4; spare cartridges, 2; friction primers, 48; slow match, yards, 1.5; port fire, 2. The same carriage could be used for the 24-pounder howitzer, which, however, was little used in the late years of the war. After the battle of Gettysburg the Napoleon guns were even used in horse batteries, and they were readily moved with 6 horses. The 3-inch rifle was, however, more frequently used for horse batteries.

16. Colt's revolver gun; caliber 2 inches, old model.—This gun in general appearance resembles very much the ordinary hand revolver, with cylinder and one long extension barrel. The trunnions are near the breech, below the axis of the gun. The revolving cylinder is just in front of these. The chambers in the cylinder are muzzle loading, evidently fired by a percussion cap. The gun was captured from the Confederates. From the United States Military Academy.

17. George's cast-iron revolver gun, caliber 1.25 inches, 18 horizontal chambers.—This represents a type of revolving cannon used by the Confederates during the time of the rebellion. The cylinder, or disk, revolves about a vertical axis, and it has 18 horizontal radial chambers. These had to be loaded in the same manner as the ordinary muzzle-loading guns, and they were fired by a hammer near the center of the disk, this hammer striking a percussion cap when the corresponding chamber came opposite to the extension barrel. The gun was captured from the Confederate army. Loaned from the United States Military Academy.

18. Clay breech-loading gun, caliber 3.1 inches, English.—This gun was captured from the Confederate army at Danville, Va. It is closed by a cylinder at the breech turning about an axis parallel to the axis of the bore, but below the bore. This cylinder is large enough in diameter to cover the end of the bore, and it is perforated longitudinally on one side of the axis, so that when the cylinder is turned by means of a projecting handle the hole can be brought opposite the bore for loading. The cylinder is then turned back to close the breech. A continuous screw thread is cut in the exterior of this cylinder, fitting a corresponding thread in the breech housing, so that in opening the breech the breechblock is slightly drawn away from the barrel, and,

on closing, it is pressed firmly up to close the breech. The piece has three sets of sights—one center sight, front and rear, and two side sights, on each side of the gun, at the rear and on the trunnion. Length, 7 feet ½ inch.

19. Three-inch Whitworth breech-loading steel rifle, captured from a blockade runner.—The breechblock is in form of a cap with a continuous screw on the inside, and it screws on the outside of the breech, instead of screwing into the breech, as in the modern guns. The block is turned by a lever with a double handle, and it is carried in a collar, which can be swung around on a vertical axis to the right when the breech is unscrewed. The piece has an axial vent, and it was fired by a friction primer. The rear sight is placed on a lug projecting to the right from the breech of the gun, and the front sight is placed on the right rim base. This gun has the peculiar hexagonal rifling of the Whitworth system, and samples of the projectile are shown. The special feature is the fine workmanship and fit of the projectile in the bore, no sabot being required on the projectile. Length of gun, 8 feet 7½ inches. From United States Military Academy.

20. Twelve-pounder breech-loading, smooth-bore gun, cast iron, found at Fort Richmond, N. Y., caliber 4.6 inches.—The breechblock is conical in shape, and it slides into the breech of the gun. It is supported by a carrier piece, which hinges on a rest bolted to the left-hand side of the gun, and, by means of a handle on the right-hand side of the block it may be swung back and out of the breech, horizontally. The manner of securing the breechblock, when in position, is not apparent. The gun is provided with front and rear center sights. Weight, 1,717 pounds. From United States Military Academy.

21. Model of 13-inch muzzle-loading, smooth-bore mortar.—A center pintle chassis replaces the old wooden platform protected by iron plates formerly used with this mortar, and this saves much time in pointing. By means of the eccentric axle at the center of the chassis the weight is thrown on the traversing wheels while pointing. Before firing the chassis is thrown out of gear. Weight, 17,120 pounds; weight of shell, 200 pounds; weight of maximum charge, 20 pounds; extreme length, 54 inches; length of bore, 2.7 caliber; range, 45 degrees elevation; maximum charge, 4,200 yards; time of flight, 30½ seconds; weight of chassis, 2,000 pounds; length of rail, 190 inches. The mortar can be elevated and depressed, either by a single handspike working in the ratchets cut in the breech, or by two handspikes fitted onto the arms attached to the trunnions, which are central on the piece. These mortars were used during the war of the rebellion, with 8-inch and 10-inch mortars of similar type. Compare 12-inch breech-loading rifled mortar.

22. Model of 200-pounder Parrott rifle.—This is a cast-iron muzzle-loading gun, reenforced by a coiled wrought-iron jacket, shrunk on

over the seat of the charge; 10, 20, 30, 100, 200, and 300 pounder Parrott rifles were used during the war of the rebellion. The larger calibers were cast hollow on the Rodman principle. Though never adopted as a part of the system of our artillery, they were largely used. They were the first high-power rifled guns used extensively in war, and they attained a range of over five miles. They are interesting as early examples of guns formed of two metals. The larger calibers had but short life. The brass base ring of the projectile for giving rotation by expansion into the rifling was liable to strip and tear off, jamming the projectile in the bore.

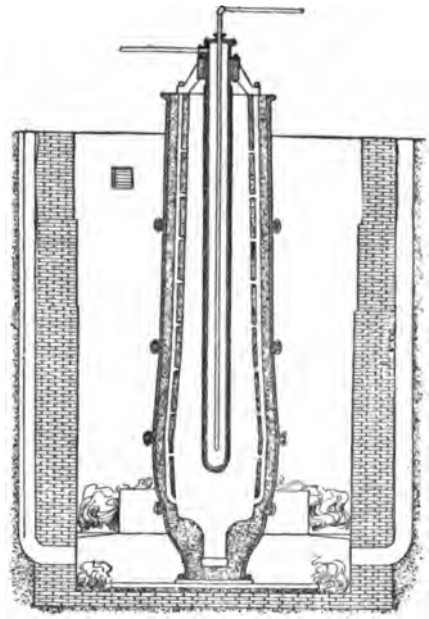
RODMAN MUZZLE-LOADING GUNS AND CONVERTED RIFLES.

Some of these guns are still retained in service for defense of narrow channels.

23. Model of 15-inch muzzle-loading Rodman gun on carriage.—The great improvement in the manufacture of cast-iron smooth-bore guns was due to the introduction of Rodman's method of casting, by cooling from the interior, coupled with the well-conditioned outside lines which he adopted for his gun. The first trial of a gun made on this plan was in 1849. Two 8-inch Columbiads were cast at the same time from the same iron. One was cast solid in the usual manner and the other according to Rodman's plan. The first was burst at the eighty-fifth round and the second endured 251 rounds. An even greater degree of superiority was evidenced in succeeding trials. The object sought to be obtained by Rodman finds application to-day in what we consider the highest principles of gun construction. Rodman pointed out the injurious effect of exterior cooling in causing the metal to be drawn away from the interior and thus weaken the part near the bore, or actually assist in the rupture of the gun by tearing apart from within outward, the outer metal not assisting that in the interior. He also showed that the effect of cooling from the interior would be to so dispose the metal that, in resisting an interior pressure, each concentric lamina of metal throughout the wall might be strained nearly to its limit to resist tangential rupture, all acting together to sustain the strain. The 15-inch Rodman gun weighs 49,000 pounds, and it is about 16 feet long. It fires a projectile weighing 450 pounds, and its powder charge is 130 pounds of hexagonal powder, which gives an average pressure of about 25,000 pounds per square inch in the bore. With this charge the range with 20° elevation is 3.75 miles. The projectile is capable of piercing 10 inches of iron at 1,000 yards. The initial velocity of 1,700 feet per second imparts a muzzle energy of 9,000 foot-tons, but so rapidly does this fall off that at 1,000 yards the energy is considerably less than that of the projectile from the 8-inch steel rifle, which starts with an energy of 7,900 foot-tons. The carriage on which the gun is mounted bears close resemblance to the

carriage for the 8-inch converted rifle described below, the buffers being pneumatic instead of hydraulic.

24. Model of Rodman's casting plant for guns.—This model shows the construction of the mold for casting cannon according to the Rodman process of cooling from the interior by means of a current of water flowing through a hollow core. This process is now used only for making the body of 12-inch mortars. The mold forms a cylindrical cavity about 16 feet deep, and the usual hollow core of the Rodman process runs down through the center, this cone being a cylinder of wrought or cast iron, fluted on the exterior, wound with small rope and plastered with molding clay. A pipe from above runs down within the core nearly to the closed bottom, and supplies a stream of cold water which flows up within the core, outside the pipe, and off by an escape pipe above. The metal stiffens enough in about twenty-four hours to allow removal of the core. The water is then admitted into the hole itself, though the metal of the casting is still at a red heat. The clay cover of the core is left in when the core is drawn out, and this seems to be essential, as it forms a protecting lining to the cavity to prevent excessive chilling of the metal. The model illustrates the construction for muzzle-loading guns, cast breech down, and it shows the core extending only part way to the bottom, with the mold following nearly the contour of the cannon; but the present practice is to make the casting cylindrical, to secure an approximately uniform strain of cooling throughout the casting; and as the mortars are breech-loading, the core extends clear through to the bottom of the mold, where it is stepped into a depression, a pot of cast iron being sunk in the sand at the bottom of the mold, with the edge slightly projecting, so that the molten metal comes in contact with the edge, and forms a joint tight enough to keep the water from escaping after removal of the core. When the water is turned into the bore, after removal of the core, it is conducted by a pipe nearly to the bottom, and thence it flows upward, escaping by an overflow pipe at the top. The former practice was to have this overflow pipe embedded in the sinking head of the casting itself, but it was found that this produced

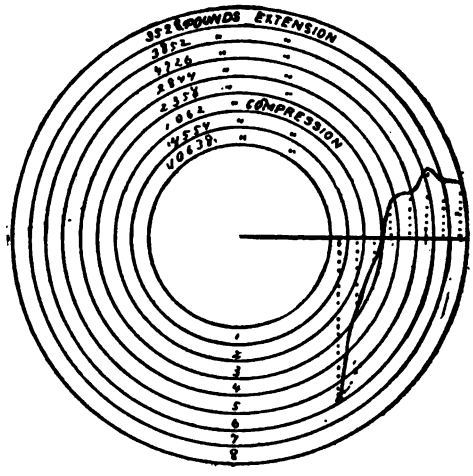


Pit and mold ready for Rodman casting.

unequal casting there, inducing cracks, and the overflow pipe is now set in the side of a cast-iron extension drum surrounding the core at the top of the casting, this drum being lowered soon after casting, so that its bottom edge dips slightly below the surface of the molten metal and becomes united to the gun casting like the pot at the bottom. The metal flows down through runners in the sand of the mold, and runs in first at the bottom, side gates from the runners admitting it higher up as the mold fills. These openings are set oblique to the radius, to give a swirling motion to the metal in the mold, this making it easier to keep the impurities from sticking to the sides. About 20 tons of pig iron and scraps of former castings are melted and poured in this operation, the reverberatory furnace being used. The cooling takes from 70 to 80 hours. A fire is kept up in the pit outside the mold to check the cooling of the exterior. A length of about 3 feet is cut from the top, and 5 to 9 inches from the bottom, or breech end, leaving room between for the body. This middle part is bored out and turned down to the proper size, tapered off at the muzzle, the weight being reduced to about 8 tons. The effect of cooling from the interior is to produce a compression of the metal near the core, and an extension of that near the outer surface, this effect depending on the rate of cooling, or the rate of flow of water through the interior. Exactly at what stage of cooling this effect is produced most extensively is not yet determined; but experiments are in progress to determinethis, and to find by means of a new thermo-electric pyrometer the time when the molten metal stiffens. It is probable that the greatest effect is produced soon after the metal stiffens, when the water flows into the hollow itself, the surface exposed to cooling being much greater than when the flow is through the core. The theory is that the metal nearest the core stiffens first, and that the outer layers, forming later, and having to contract more in cooling than the partly cooled metal within, must compress the interior layers. Evidently it will be impossible for the outer layers to shrink the normal amount, and they will be stretched like the outer hoop of built-up guns. The metal close to the exterior, however, which may stiffen earlier from radiation of the heat to the outer walls of the mold, seems to show a reversal of these strains. This outer skin is turned off, and measurements of tension are made only on the layers corresponding to the inner and outer ones of the finished body. Test disks are cut from the castings close to the top and bottom ends of the body; and three rings, having a section of one square inch, are removed from the disks, the diameters of these rings being measured before and after removal. The inner ring at the breech must expand enough to indicate an original compression at the bore of from 5,000 to 9,500 pounds per square inch; and the outer ring must contract, the strain of the exterior iron usually being about 4,000 pounds per square inch. Only a small ring

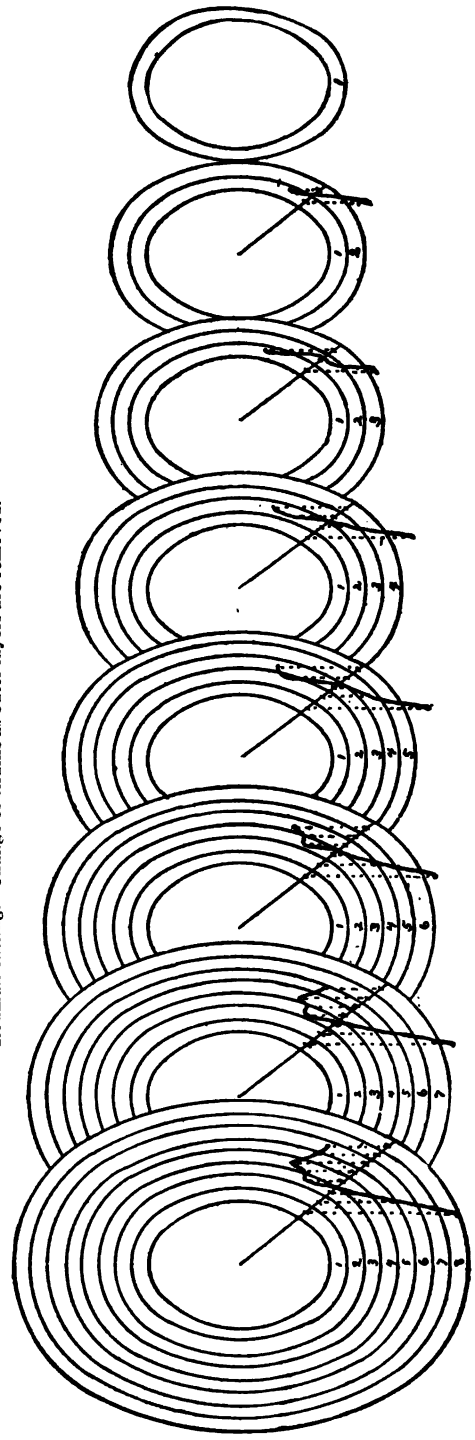
is removed from the muzzle end, and this must indicate a compression lying between 5,000 and 13,000 pounds per square inch, the initial tension being usually greater near the top than near the bottom. The reason for this difference is not clear; but it may be due to greater heat at the top of the pit, outside the mold, than at the bottom, allowing less exterior cooling of the casting at the top.

To show the strains produced in Rodman castings, illustration is given of a disk taken from the muzzle end of one casting and cut into eight successive rings. At the right the curve of strains is shown, the distances below the horizontal line indicating compression and those above indicating extension, the neutral point being just outside the third ring from the bore. It is to be noted that the outmost ring shows the reduction of strains mentioned above. It appears undesirable, therefore, to leave the outer skin on a finished gun casting, as a line of weakness may be expected a little below the surface. The old method of determining initial tension was to cut the entire disk through radially at one point, as at the horizontal line, for instance, and to calculate the tension by the variation in the opening from the width of the original cut. Inspection of the strains indicated in the diagram shows that the variation in the radial slit in the old method gives merely the resultant effect of many varying strains throughout the disk, and no data for calculation of the strain at any particular point of the disk. The old theory was that the strain of extension on the exterior was equal to that of compression at the bore, but new results show that the former is much less than the latter, and that proper measurement would give about half the compression supposed to exist at the bore in castings tested only by the old method. The new method is due to Captain Crozier, of the Ordnance Department of our Army, who, a few years since, at Watertown Arsenal, removed a full disk from a casting and cut it into rings, measuring the expansions and contractions, applying to cast iron the methods used by General Mayevski in Russia, and later by Noble in England, for determining strains in steel hoops.



Strains in Rodman casting. Distances below horizontal line indicate compressions; distances above horizontal line indicate extensions.

By making measurement of the rings, not only before removal of



Rodman casting.—Change of strains as outer layers are removed.

Distances below oblique lines measured on dotted lines indicate compressions
Distances above oblique lines measured on dotted lines indicate extensions.

any from the original disk and after the separation of the rings, but in the disks of different sizes left by cutting off exterior rings, it was possible to determine the tensions in disks of varying diameters, corresponding to the sizes at different points of the tapering muzzle. The illustration of this result shows how the compression of the inner metal decreases as the outer rings are removed. Also, how the neutral point, when the fifth ring is removed, shifts to a point between the second and third rings, while the third ring becomes stretched instead of compressed. A reversal again takes place when the third ring is removed and the second ring becomes stretched, the neutral point lying between the two remaining rings. These recent results of careful and suitable measurements bear out fully the theory of Rodman respecting the advantage of cooling cast-iron guns from the interior, and confirm his genius. Observing the opposite effect in solid cylinders, necessarily cooled from the exterior, where the inner metal tends to become spongy, being drawn outward by clinging to the outer layers, which stiffen first, he introduced the new method to secure sound metal near the bore, and to produce advantageous strains, the old method producing directly opposite strains. The effect of cooling from the exterior is particularly apparent in chilled rolls, which often break apart under the strains produced and show cavities within. Even cooling from the interior may be carried on so rapidly that excessive strains will occur, causing rupture at the outer surface; and this has been illustrated in many gun castings, which have burst asunder in the lathe, or even in the mold.

25. Eight-inch converted muzzle-loading rifle mounted on barbette carriage.—These guns are the result of the recommendations of the heavy gun board, which met in New York City in 1872. They were proposed as an expedient for converting the comparatively useless 10-inch smoothbores into rifled guns, to meet the increasing thickness of armor carried by vessels. When this system was inaugurated the 8-inch caliber was seen to be a gun that would equal in power the existing English guns of like caliber, and it was hoped that the extension of the system to guns of larger caliber would prove a success. As an additional reason for the adoption of the system our forts were constructed with casemates adapted to accommodate a gun of about the dimensions of the 10-inch Rodman smoothbore, and the conversion of this gun into a rifle afforded at that time the best and the only available means for increasing the efficiency of the casemated forts to a maximum. The conversion of guns of larger caliber was not carried on to any great extent, and the 8-inch converted rifle was the only caliber adopted and manufactured for issue to the service. One very important element in causing the abandonment of the change was the great increase in length of bore demanded for modern guns, the converted rifles being too short for full efficiency. Compare velocity

obtained with 8-inch steel rifle and the length with these points for the 8-inch converted rifle. The piece is composed essentially of two parts, viz, the case, which is the old Rodman 10-inch smoothbore bored up to a diameter of 13.5 inches, and a lining tube of steel or of coiled wrought iron. The tube consists of two parts. One part extends the entire length of the bore and contains the rifling; the other is shrunk on the inner tube, which has its exterior portion cut away for that purpose. A double tube is thus formed, extending 32.75 inches from the rear end. The compound tube thus formed has the same exterior diameter throughout the entire length, and it is made to fit accurately to the bore of the cast-iron casing. The bottom of the tube is closed with a wrought-iron cup-shaped plug screwed into the inner tube. The tube is inserted into the casing from the muzzle, and is secured from working out by a muzzle collar screwed in at the face of the piece, and from turning in the casing by a steel pin tapped through the casing into the tube. A gas escape or indicator is bored obliquely through the breach of the casing opposite the vent. Should the inner tube split under the action of firing, the fact would be indicated by the escape of gas through this hole. There was no chamber proper to the gun. The rifling stops at a point 10 inches from the bottom of the bore, the diameter of the unrifled portion being equal to that of the rifled portion across the lands. The piece weighs 16,160 pounds, and has a counter preponderance of 630 pounds, which is corrected by an eccentric ring of bronze attached to each trunnion. Five hundred rounds were fixed as the number necessary to prove the endurance of these guns, and some have been fired 817 times, remaining still serviceable. These rifles have 14.7 calibers length of bore. The charge is 35 pounds of hexagonal powder, and the projectile weighs 180 pounds. The result of the latest trials with the charge gave an average pressure in the bore of 30,500 pounds per square inch and an initial velocity of 1,385 feet per second. From trials made at Sandy Hook in 1883, using chilled-iron projectiles, it was shown that the power of the gun was sufficient to more than penetrate 8 inches of iron armor at 1,000 yards, thus making it an effective weapon to defend narrow channels against the passage of vessels carrying iron armor of about 8 inches or less.

A specimen of the wrought-iron tube used for converting smoothbore cast-iron guns into rifles is shown in the exhibit.

The Butler shot used for this gun was invented by Capt. J. G. Butler, Ordnance Department, United States Army. It has for sabot a soft metal ring screwed on the base, the ring having a groove in the rear surfaces, forming a narrow lip on the outer edge and a wider one on the inner. The powder gases acting on the outer lip, force it out into the rifling to give rotation to the shot and check the flow of gas past the shot, at the same time tending to press the inner lip more

firmly on the shot and prevent stripping of the sabot. It was the first base sabot fully answering the conditions for muzzle-loading rifles of large caliber, as all others proposed before had worked irregularly, resulting in great variation of the powder pressures in the gun. Americans have taken the lead in inventions for giving rotation to a shot in muzzle-loaders by means of sabots. The English used studded projectiles (represented in the exhibit by an Armstrong 8¼-inch shell), and long after the sabot had been used by the United States adopted a sabot merely as gas check in addition to the studs, finally abandoning the studs and relying on the sabot alone.

The Eureka sabot is another form sometimes used with our large muzzle-loading guns. This sabot is a soft metal cup placed on the base, concave side to the rear, fitted with a ring lip projecting forward over the sides of the projectile, which is beveled off to receive it. The gas pressure flattens the cup, pressing the lip forward and outward into the rifling. With large shell difficulty has been experienced from weakness at the base where the sabot is fastened by an axial screw. The use of such sabots was rendered unnecessary by the adoption of breechloaders. Since the projectile does not need to be small enough to slip in from the muzzle, a forcing or swedging system is followed, the accepted practice being to let into the rigid projectile, in an undercut groove near its base, a ring of soft metal, copper or composition, making the diameter slightly larger than the bore, this ring being forced into the lands of the rifling to give rotation and prevent the escape of gas past the seat. Captain Butler also suggested this new system here, though it at the same time appeared independently abroad. A lead coating had previously been used abroad, but that leaded the bore, and the projectile could not be used with rifling which had an increasing twist. Dr. W. E. Woodbridge is recognized as having suggested the first expanding projectile for muzzle-loading rifled cannon, his invention dating back to 1850, about which time it was tested before a board of ordnance officers. Many forms embodying this principle intervened between this original projectile and the Butler form, which fully satisfied the required conditions. The carriages formerly used for the 10-inch smooth bores were not strong enough for the converted rifles, so these had to be altered and strengthened. The carriage consists essentially of two parts, a bottom and a top carriage. The bottom carriage contains the chassis rails on which the the top carriage runs; the hydraulic buffer for checking recoil, and the traverse circle wheels on which, together with the pintle, the whole carriage rests. The top carriage carries the gun and the elevating apparatus.

The gun is elevated and depressed by means of a circular toothed rack, to which motion is transmitted by simple multiplied gearing worked by a hand wheel on the left of the top carriage. The pro-

jectile is raised by means of a crane attached to the front part of the lower carriage, and the gun is loaded when "from battery." A wedge-shaped incline is bolted to the top of each chassis rail near the rear end, and this materially assists in checking the recoil and permitting the carriage to run into battery. The hydraulic buffer is securely fixed in the front part of the lower carriage. It consists of a cast-iron cylinder 78 inches long, with an interior diameter of 8 inches. A wrought-iron piston rod passes through the rear cylinder head, and it is secured to the rear of the top carriage by a wrought-iron cross head. The piston head is pierced near its circumference on opposite sides of the rod with 2 holes seven-eighths of an inch in diameter; these holes flare out both ways, allowing free passage to the fluid, permitting the top carriage to run back slowly without undue strain. The top carriage is provided with two sets of wheels, those in rear having eccentric axles. In recoiling, the carriage starts on sliding friction, which becomes rolling friction when it accomplishes part of the rise, the ascent absorbing a considerable portion of the recoil. To prevent the carriage running into battery after striking the counter hurters, couplings are attached to the bottom transom of the top carriage and to the sides of the chassis rails. The top carriage is released by means of levers and permitted to run into battery. Attached to the rear end of the chassis is a geared windlass for the purpose of drawing the gun from battery.

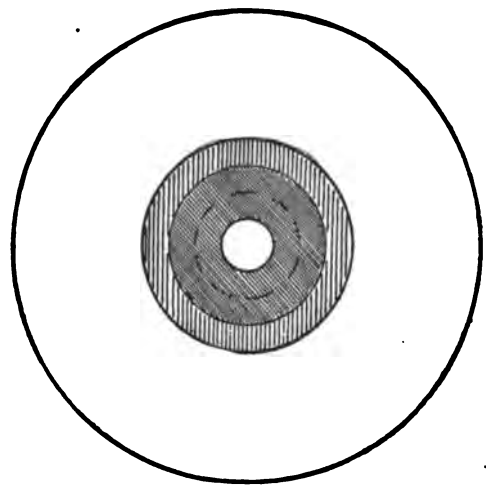
In the English Vavasseur carriage the hydraulic buffer is composed of two cylinders, filled with liquid and arranged so that the piston of one is being drawn out while that of the other is being pushed in, connection between the cylinders allowing compensation of the amounts of water in each. The piston heads are composed of two parts, both perforated, one fixed to the rod and the other turning on it, the motion being controlled by a projection on the circumference working in a spiral groove on the inner surface of its cylinder. This motion is so adjusted as to close progressively the openings and graduate the resistance of the liquid in its flow to the decreasing velocity of recoil as the gun runs back. (See reports of Chief of Ordnance for 1877 and 1886; report of Board on Fortifications and other Defenses, 1885.) The double piston head here described is of American invention. A device used on the carriage for the 100-ton cast-iron Italian gun accomplished this graduation of resistance without double piston heads by means of wedge-shaped bars fixed longitudinally on the inner surface of the cylinder. Slots on the outer edge of the piston head run along these bars, which fill the openings more and more as the recoil progresses. A variation of this principle has tapering rods, with round holes in the piston head, producing the same effect. The Italian method has been applied to army carriages of recent construction, the outline of the bars being such that a uniform resistance is

produced during the variable motion of recoil. In the navy the same principle is applied, but instead of bars fastened on the inside of the cylinders, grooves of varying width are cut in the interior surface, the piston head being circular, so that the flow of liquid is regulated in a similar manner.

MODERN BREECH-LOADING CANNON.

SEACOAST CANNON AND CARRIAGES.

26. United States 12-inch breech-loading steel rifle.—The description of this rifle will serve to give a general idea of the method of making all built-up guns. The gun, instead of being made in one piece, is composed of many parts of steel, all forged, and properly tempered and annealed. By "built up" is meant surrounding the central tube, which extends nearly through the gun, with concentric rings or hoops. These hoops are arranged in one layer or more. The hoops are so made that their interior diameters are slightly less than the exterior diameter of the surface to be covered. In assembling the gun, the hoops are expanded by heat until their interior diameters are great enough to permit their being slipped over the tube or hoops to be covered, and they are then allowed to cool in place. By this construction the tube is under a strain of compression, and the exterior hoops are under a strain of extension, the neutral line, or line of no strain, lying between the two.



Expansion of hollow cylinders. Illustration of Barlow's law.

A diagram illustrates Barlow's law of the unequal strains produced in a solid ring of homogeneous metal by expansion from within, and indicates the advantage of substituting the built-up construction. The inner ring (shaded heavily) represents the section of a tube with walls equal in thickness to the bore. Suppose this to be enlarged by pressure from within until the bore gains the size of the original exterior. Assuming that the metal maintains the same volume, the exterior shaded ring shows the new section; and while the inner circumference is enlarged three times, the outer circumference is enlarged but little more than one and one-third times, showing that

the strain on the inner metal is much greater than on the outer, as is evident from mere inspection of the figure. The outer ring in the figure represents the size to which the outer layer of metal would need to be stretched to produce the same proportional enlargement as the inner layer and therefore the same strain. This would involve an absurd enlargement of volume of the metal. The actual result would be to slightly reduce the area of the cross section. The law deduced is that the strain communicated to the metal varies inversely with the square of the distance from the axis. The inmost layer, therefore, might reach its breaking point before the outer metal, and a crack might be started within which would tear outward so that the tube would rupture before the full strength of the outer metal had been brought into play. If, however, each layer progressing outward were originally stretched slightly more than the one within, it is evident that the inner layers would be more supported by the outer layers against internal pressure, and the full advantage would be obtained when these strains were so proportioned that the layers would reach their limit of elasticity at the same instant. Then the tube would stand a much higher internal pressure than before. A tube so constructed with walls half a caliber thick (indicated by the dotted circle) would be one and one-half times as strong as a ring of homogeneous metal a full caliber thick. Such a construction will evidently bring the inner layers into a state of compression; and this is a decided advantage, as they then can be expanded more before breaking than if in their normal condition. In practice, the law of variation of strain is more complicated than that given by Barlow. Its application to United States army gun construction has been ably made by Captain Birnie, of the Ordnance Department of the Army; but the old law, approximately correct, gives a striking illustration of the disadvantage of the solid gun; for, though such initial strains as are described can be produced to some degree in cast iron by the Rodman process of casting, yet they can not be as fully controlled as in the built-up guns, to develop the full strength of all parts of the gun when fired. While the ideal of tangential strength is secured more fully by wire wrapping, in which each layer is very thin, difficulties encountered in giving sufficient longitudinal strength by this method of construction have delayed its adoption, and the usual practice is to secure the desired condition, approximately, by the use of successive layers of hoops, made as thin as the conditions of manufacture allow, the great multiplication of very thin hoops being found undesirable.

To Dr. W. E. Woodbridge the credit belongs of having first suggested wire-wound guns. He presented his plans to the Ordnance Department as early as 1850, and a gun of 2½ inches caliber was made in 1862 and fired 1,327 rounds; the charge being 1 pound of powder, and the projectiles weighing from 7.8 to 10.2 pounds. The subject was afterwards taken up in England by Longridge, and in France by

Captain Schultz, the inventor of the Schultz chronoscope, shown in the exhibit. Two wire-wound guns are now undergoing tests by the Ordnance Department, one devised by Dr. Woodbridge, and the other by Captain Crozier, of the Ordnance Department.

The forgings for the 12-inch steel gun were made at the Bethlehem Steel Works, South Bethlehem, Pa. In constructing the 12-inch steel rifle the tube is enveloped at the rear end by a long hoop or "jacket," extending beyond the trunnions, and at the front end by 7 shorter and thinner hoops from the jacket to the muzzle. Outside these muzzle hoops, slightly overlapping the front of the jacket, and extending forward nearly half way to the muzzle, is a row of 2 larger hoops, the rear one abutting against the shoulder on the jacket, and locking the jacket to the rear hoop of the inner row over the muzzle. This locking is accomplished by having a recess in the inner surface of the larger hoop, to fit over corresponding fillets on the jacket and the rear muzzle hoop. A split filling ring is set in between this locking ring and the shoulder on this jacket, to compensate for any reduction in length in the hoop after heating it and shrinking it on in place. A row of 5 large hoop envelopes the jacket throughout its length, the front hoop partly overlapping the rear hoop of the outer layer of the muzzle hoops. The rear hoop of this row is extra long, and it is provided with an interior recess which locks over two shoulders on the jacket, the object being to increase the longitudinal strength of the jacket where the pull of the breech mechanism is sustained. The front hoop is enlarged on the interior, near the front, and the shoulder in the hoop abuts against a corresponding shoulder on the front part of the jacket. Outside this row of breech hoops, extending a little beyond the rear end of the front hoop, is another row of 4 hoops. The front hoop of this outer row, made thicker than the others, carries the trunnions. The jacket projects to the rear of the tube to hold the breech screw. The thickness of the tube over the powder chamber is 3.9 inches and at the muzzle 2.55 inches, the tube being gradually reduced in exterior diameter from 22 inches under the jacket to 18.1 inches at the muzzle, forming a series of cylindrical steps under the muzzle hoops, which vary in interior diameter to correspond. The front muzzle hoops are each bored to two different diameters to fit over the steps on the tube, and are locked together by lips and recesses. The other joints in the envelope of the tube are plain abutting joints. Under the front end of the jacket the tube has a projecting fillet 0.25 inch high, while the exterior at the rear is reduced in diameter by two steps, the interior surface of the jacket conforming to this shape. The tube and jacket are coupled together with 2 steel coupling pins, which are driven into holes drilled partly in the tube and partly in the jacket near the front end of the latter. The pins are inserted tangentially instead of radially as formerly.

In the interior of the gun, at the rear, the screw thread to hold the breechblock is cut on the jacket, which is reduced in interior diameter in rear of the tube. A space of 0.05 of an inch is left between the rear end of the tube and the corresponding surface of the jacket, and a small conical lip on the rear end of the tube projects over this opening. A copper calking ring is inserted between the lip of the tube and the corresponding surface of the jacket. At the rear end of the tube is formed the gas-check seat with its taper entrance, the total length of the two being 4.55 inches. The powder chamber is 14.2 inches in diameter and 63 inches long, breech closed, measured from the front of the obturator. This chamber is joined to the rifled bore by a conical slope 18 inches long. The front part of this slope forms the seat for the band of the projectile. From the front of this slope the tops of the lands of the rifling are beveled for a length of 48 inches, giving a diameter in rear of 12.06 inches and in front of 12 inches. The rear ends of the lands have the same slope as that of the shot chamber. The rifling is a semicubic parabola, diminishing from 1 turn in 50 calibers at the origin to 1 turn in 25 calibers at 24 inches from the muzzle, and then remaining uniform to the muzzle. The breech plate is of steel, and it is intended to carry the gears necessary to give rotation to the block and to cover and protect the smaller movable parts from the weather and from accident. It also supports the swinging tray which carries the breechblock when drawn from the gun. This plate is bolted to the rear of the gun by screw bolts. The De Bange gas check is used, and the breechblock has 4 threaded sectors corresponding to 4 longitudinal slots in the screw threads within the breech. When the breechblock is pushed in, an eighth of a turn engages the threaded portions of the screw. The breechblock is traversed by a spindle, terminating in front in a head shaped like a mushroom. The head receives the pressure of the powder gases, and it is supported by a plastic ring surrounding the spindle and interposed between the mushroom head and the face of the breechblock. This ring is composed of asbestus, graphite, and tallow, contained in an envelope of canvas, and sustained by 2 cup-shaped steel rings. The pressure on the head forces out the gas-check pad against the walls of the gun chamber, preventing the escape of gas. The total length of the gun is 36.6 feet and it weighs 52 tons. The charge of powder for this gun is 450 pounds of brown prismatic powder, the projectile weighing 1,000 pounds. The initial velocity is 1,975 feet per second and the penetration in steel at the muzzle is 25 inches.

27. United States 10-inch breech-loading steel rifle, mounted on free-recoil carriage.—This gun is very similar in design to the 12-inch rifle, and it consists of 1 tube, 1 jacket, and 27 hoops. The total length is 30.6 feet, and the maximum diameter of the breech is 38.5 inches. The projectile weighs 575 pounds, and the charge of powder, weigh-

ing 250 pounds, gives to it a muzzle velocity of 1,975 feet per second. The pressure in the powder chamber is 37,000 pounds per square inch. The penetration in steel at the muzzle is 20.4 inches. The total weight of the gun is 30 tons. The free-recoil carriage on which this gun is mounted consists principally of two horizontal chassis rails with hydraulic buffers attached to the top of the rails at the rear. Two cheek pieces, supporting the trunnions of the gun, move on rollers along the rails. The gun moves freely to the rear for a short distance before the buffers are reached. The space passed over during the "free recoil," allows measurements to be made of the acceleration produced by the action of the powder. The Sebert recoil velocimeter is used in connection with this carriage for determining the various circumstances attending the free recoil of guns, and it has given valuable data regarding the designs of guns and carriages. This instrument is described among ballistic machines under the head of shooting gallery.

28. United States 8-inch breech-loading steel rifle, mounted on service barbette carriage.—This gun resembles very generally the two preceding guns. It consists of one tube, one jacket, and 18 hoops. Its total length is 23.21 feet and it weighs 14½ tons. The pressure in the powder chamber is 37,000 pounds per square inch, the same as in the other seacoast guns, and the initial velocity is 1,975 feet per second. It requires a charge of powder of 130 pounds, and fires a projectile weighing 300 pounds, capable of penetrating 16 inches of steel at the muzzle. This gun, as well as all of the United States steel guns on exhibition, was built at the Army Gun Factory, Watervliet Arsenal, West Troy, N. Y. The carriage on which this gun is mounted is the type of carriage to be used for all seacoast guns. It consists essentially of three parts: a base plate, a revolving carriage of gun iron, and a top carriage of bronze, made to move lengthwise on the latter—the whole weighing about 28 tons. The base plate is circular in shape and considerably broader at the bottom than at the top, to form a stable support. It holds a center pintle which keeps the lower carriage from moving under the shock of discharge. The lower carriage fits over the pintle and rests on conical rollers of steel, which in turn rest upon the base plate. A circular frame holds the rollers in place, with small ends toward the pintle. These rollers permit the carriage to be traversed with great facility, the bottom circular surface of the lower carriage and the top surface of the base plate being coned off to form contact with the rollers. The top of the lower carriage is formed into two longitudinal rails, containing a number of rollers, on which the top carriage is constrained to move. The top carriage is made of bronze, in one casting. It contains the hydraulic cylinders by which the recoil of the gun is checked. The trunnions of the gun rest on this carriage in beds formed at the top. The piston rods for the recoil

cylinders are firmly fixed in front to projections on the lower carriage. This carriage permits a recoil of about 3½ feet. The cylinders, one on each side, have two throttling bars varying the area of orifice in the piston in such a manner that the resistance on the piston is constant throughout the recoil. After the gun has recoiled it returns into battery by the action of gravity, the top rails of the lower carriage being inclined to the rear and upward at an angle of about 4 degrees. The hydraulic buffers prevent any shock as the gun runs into battery.

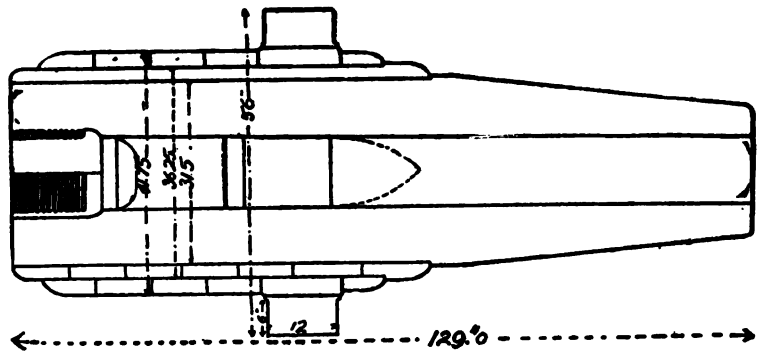
The carriage is traversed by means of a sprocket wheel in front, properly geared, and a chain firmly attached to the bed plate. Two men working on the handles in front can move the gun and carriage with comparative ease. The gun is elevated by a small hand wheel at the rear. A rack is attached to the gun, and a small gear engages in this by means of a friction wheel. There are two wheels in front, one on each side of the carriage and connected to the wheel in the rear, to be used in elevating the gun in case of necessity, but the guns are so nicely balanced about the trunnions that one man standing on the platform can elevate and depress the gun with ease. A platform with railing is built on at the rear of the lower carriage for the men in charge of the gun.

The shot is raised to the bench by a long lever arm which projects from the rear of the lower carriage. This lever is operated by a worm gear. The rear end of the arm is forked, and a notch is made in the end of each fork, these corresponding to two pins projecting like trunnions from the sides of the shot tray. The shot is brought to the gun on a small truck, the tray containing the shot being supported by its trunnion pins on the sides of the truck at such a level that the pins will slip into the notches at the end of the lever arm when the latter is lowered. Raising the lever lifts the tray and shot from the truck to the breech, and the shot is pushed in from the tray. Two men can raise the shot with ease.

29. Model of United States 8-inch breech-loading steel rifle, showing construction.—This is a wooden model about 2 feet long, showing the general method of constructing the gun. It consists of the tube, jacket, and hoops so arranged that they can be assembled or taken apart, and this serves to counteract the general impression that the large guns are "cast" solid instead of being composed of many pieces of forged steel. Loaned from Military Academy.

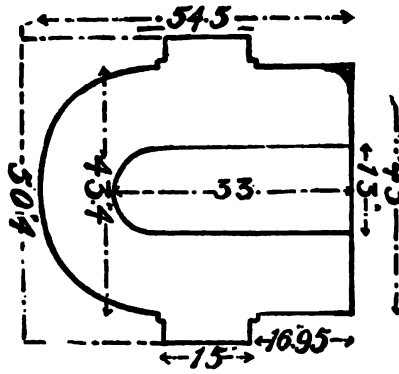
30. United States 12-inch breech-loading rifled mortar.—These mortars are short rifled pieces intended for high-angle fire and especially adapted for the defense of seaports. They weigh about 14¼ tons and throw a very heavy elongated shell, containing a large bursting charge, to a distance of 5¾ miles. The shells weigh 800 and 1,000 pounds, and they are capable of piercing the armored deck of any vessel afloat. The pieces will be placed on shore in sunken batteries in groups of 16,

and so trained that any desired number of the pieces in the battery can be fired in the same line of direction against a single ship. The most serious question raised concerning the employment of rifle-mortar fire has been in regard to its accuracy. Their employment in groups will do much to overcome this difficulty by greatly increasing the chances of hitting, but the results of experiment show a remarkable



Longitudinal section of 12-inch breech-loading rifled mortar.

improvement in accuracy as well as range with these mortars over the old smooth-bore mortars. The old 13-inch seacoast mortar, with full charge of 20 pounds, gave a range of only 4,200 yards, of which only 2,200 yards would be effective against a 3-inch deck, and its accuracy could not be depended upon. Unlike the high-power rifle, the effective blow from the mortar shell gains in power with the range, as the striking force depends on the distance the mortar shell falls, and it must mount higher to gain the longer ranges, while the power of the rifle projectile depends principally upon the velocity of projection and the striking velocity diminishes with the range.

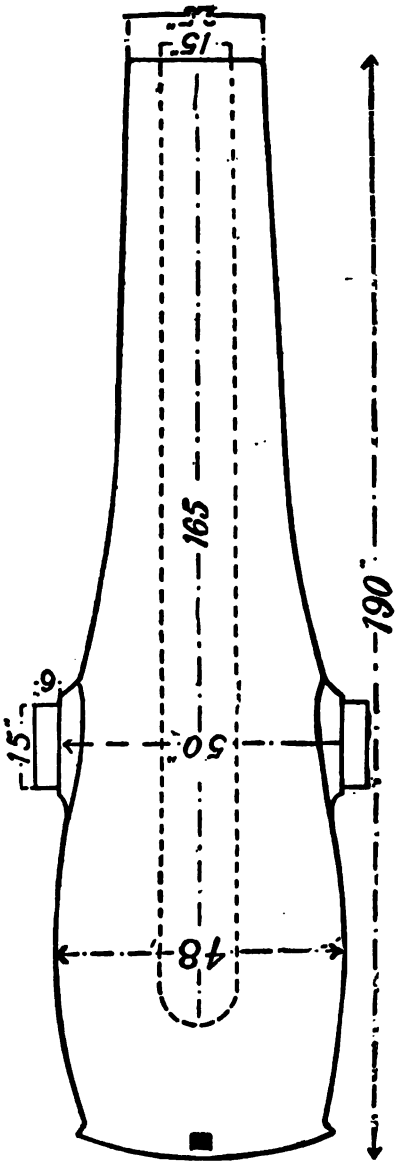


Old 13-inch mortars.

One great advantage with mortars for seacoast service is that they can be protected from the direct fire of high-power guns, while similar mortars could not be used accurately on shipboard to give high-angle fire that would pass over the parapet into the mortar battery. The relative cost of mortars is less than that of guns of the same caliber. The 12-inch rifle costs about $50,000, to $8,000 for the mortar; and the cost of emplacement is $225,000 for the rifle, to $10,000 for the mortar.

The modern mortar, shown in longitudinal section, presents little

likeness to the apothecaries mortar, which suggested the name for the old type, illustrated on the same scale by the old muzzle-loading cast-iron mortar of 13-inch caliber used during the rebellion, and by the old mortars of the time of the Mexican war. The new mortar has more the size and proportions of a gun, as is seen by the outline of a 15-inch Rodman gun, drawn to the same scale. Its right to the name of mortar comes only from its similarity of use for throwing shells high into the air to reach, from above, objects like the deck of a vessel that could not be hit by the direct fire of high-power guns, the latter being effective only against the sides of the vessel. In shape it is a large howitzer, rather than a mortar; but being used like the old mortar for firing at much higher angles than was common with the old shell cannon called howitzers, it is called in this country a mortar, though often designated a howitzer abroad, where rifled mortars have been used for some years.



15-inch Rodman gun.

Col. T. T. S. Laidley, Ordnance Department, United States Army, recommended the use of rifled mortars long before they were used in Europe.

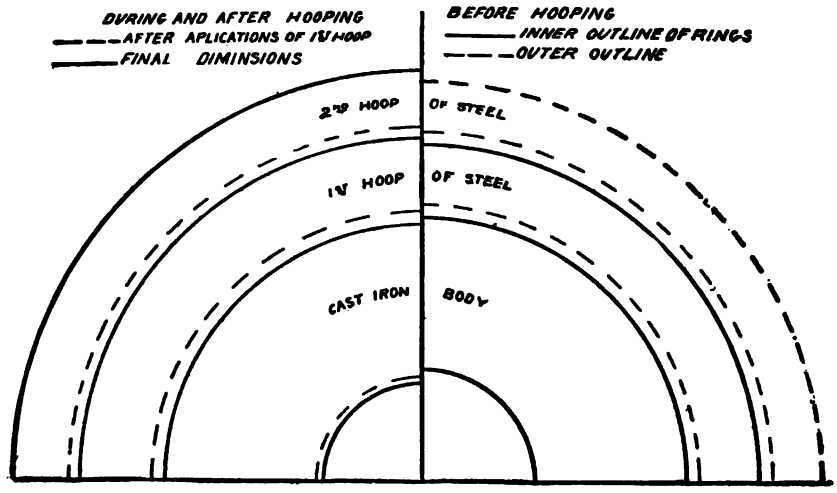
While the old mortar was a short, smoothbore, muzzle-loading piece, throwing a spherical shell, the new mortar is a breechloader 129 inches long, rifled in the bore to make it possible to throw an elongated projectile. The rotary motion given to the projectile by the twist of the rifling is necessary to keep the point of the shell in the direction of flight, much as the spinning of a top is necessary to keep it balanced on its peg. Going point on, the shell encounters less resistance from the air than if moving sidewise, and presents to this resistance a section

no greater than the caliber, as with a round ball, while the added weight due to its length gives it greater inertia to maintain its velocity, and causes it to carry farther than the round ball. A 12-inch round shell would weigh only 216 pounds. A closer fit in the bore, too, is practicable with the long shell, as a copper band encircles the hard metal of the shell and wedges into the rifling grooves, securing greater uniformity of motion in leaving the piece, and thus greater accuracy of fire. In these mortars we have almost the only remaining example of the use of cast iron as a part of the system; for, while the modern high-power rifled gun is made up wholly of steel, the inner tube or body of the mortars is of cast iron. The high pressures and strains in the larger guns put the use of cast iron out of the question for them; and even for mortars the all-steel construction presents some decided advantages, since by it a more powerful piece of less weight can be obtained.

The shape of the cast-iron body is shown in the figure, with bore extending through and fitted at the rear with slotted screw threads to hold the screw breech piece. This body is cylindrical at the rear for over half its length, with a slight shoulder at the front of this portion to prevent slipping backward through the hoops, and a taper thence to the muzzle. Over this cylindrical portion the figure shows, first, a row of seven hoops. The front hoop has a shoulder at the front, corresponding in use to the shoulder on the body. Outside this row of hoops is another row of six hoops, completing the envelope. One of these outer hoops, the second from the front, carries the trunnions, as shown in the figure. The hoops of each row are shrunk on, so producing the desired strain on the inner metal. Difficulties of construction make it desirable to use several short hoops in place of one long hoop or jacket.

The steel hoops and other steel parts are made at the Midvale Steel Works, Philadelphia, and sent, roughly shaped to size, to the contractors for finishing. Besides the steel hoops there are steel parts furnished which go to form the breech mechanism. This is of the interrupted-screw type, commonly known as the French, but really the invention of Chambers, an American. A full screw is cut on the cylindrical breechblock, and then the screw threads are cut away parallel to the axis of the block at three points, leaving three spaces plain and three threaded, equal in width. The recess in the breech has screw threads similarly cut and slotted, so that when the threaded sections of the block are opposite the slotted sections of the breech the block can be pushed in. Then one-sixth of a turn engages all the threads. The threaded portion, of course, has to be longer than if the full thread were used, but in the latter case the block would have to be turned a great many times to screw it home. When pulled out the breechblock rests on a hinged tray, which swings to one side, uncovering the breech for loading. The hoops are bored to a definite size, then the cast-iron tube or body is turned to a diameter about five one-

hundredths of an inch larger than that of the interior of the small hoops. These hoops are expanded by heat until they will slip over the body. They are put on from the rear, singly, and cooled in place, then they are turned off on the exterior with reference to the larger hoops, and the latter are applied in like manner. The front hoop of each row is forced forward to the shoulder, and the rear hoops are forced as close as possible to those in place, in order to make a continuous envelope. The application of each row of hoops contracts the bore of the cast-iron body six to eight one-thousandths of an inch, although the thickness of the walls is 9½ inches. By means of the star gauge the original diameters of the bore are measured at short intervals throughout the length, and remeasurements are made after each row of hoops is applied. The hoops are heated in a gas furnace to a temperature not greater than 500° to 600° F. above the temperature of



Effect of hooping.

the shops, higher temperature being avoided in order to prevent all formation of scale on the interior. This expands the hoop enough to give a play of about five one-hundredths of an inch in slipping on the mortar. When the hoop is in place it is clamped securely to the front of the piece by long side bars, drawn up powerfully by hydraulic or screw pressure, and a spray of cold water is at once driven against the outer surface to cool it. The hoop is cooled at the front first, in order that it may nip there before it nips at the rear, as otherwise it might shrink away from the front hoop in cooling and leave a wide joint. The clamps are drawn tighter and tighter as the hoop cools, and they are released only when the hoop is firmly shrunk in place. Then another hoop is heated and put on, the mortar being horizontal during the operation.

A figure illustrates the "effect of hooping." In the portion to the

right the figure shows the sizes of the body and the hoops before they are assembled; in the portion to the left, the effect produced by applying the hoops. By the application of the small hoop to the body the body is compressed and the hoop enlarged. By the application of the larger hoop the body is still further compressed, the small hoop is reduced in size, but not quite to its original dimensions, and the outer hoop is enlarged.

Two of these mortars are shown in the exhibit, outside the building, on two kinds of carriage described below.

In this connection it may be said that the old idea of the importance of great weight in cannon to lessen recoil does not apply particularly to mortars since the methods for checking recoil and reducing the shock on the carriage have been so fully developed. On the other hand, since the mortar has to be restored to its firing position by means of springs which are not required to bear the full effect of the recoil, advantage in reduced length of springs can be obtained by having a lighter mortar. This would be given by the all-steel construction now proposed, and at the same time a more powerful piece would be obtained, throwing a heavier shell farther.

31. Canet carriage for 12-inch rifled mortar.—This carriage is one of those made abroad for trial in this country, but it was not considered so peculiarly well adapted to the wants of our service as the spring-return carriage described below. The Canet carriage has hydropneumatic cylinders for the purpose of checking recoil. The operations of traversing, elevating, and loading are done by hand. The carriage consists mainly of a revolving carriage resting on rollers, which run on a circular bedplate essentially as described for the 8-inch rifle carriage, and supporting what may be called a "rocker carriage," which in turn carries the slides on which the mortar rests. The "rocker carriage" is of peculiar form. Its cheeks are half-moon shape, with the curved part down, and the sides of the revolving carriage are hollowed out at the top to correspond in curvature, so that the cheeks of the rocker carriage rest in these hollows and turn in them on a horizontal axis like trunnions in trunnion beds. The trunnions of the mortar rest on slides which move along the rails formed by the flat top of the rocker carriage. A curved transom connecting the slides holds the mortar with the axis of the bore parallel to the rails. Hence, the mortar turns up and down with the trunnion carriage, and has no independent motion except along the rails. The pieces which form the slides are bored out to form the hydraulic cylinders, the pistons being attached in rear to projections from the rails. The rocker has teeth on the curved edge, and a toothed wheel turned by a winch engages these teeth for elevating and depressing the muzzle of the piece. Under the gun is an "accumulator." This is a third cylinder, which has a piston in it with oil on one side of the head and

air on the other, the oil compartment communicating with the hydraulic cylinders. When the gun is ready for firing the slides are run forward, and this brings the center of gravity of the gun near the center of the rocker carriage. In this position changes in elevation can be made with ease. To hold the gun in this position for firing, the air in the accumulator is compressed by an auxiliary air pump to about 900 pounds per square inch, and when once compressed it is supposed to last for a considerable period. In recoiling, the cylinders are pushed over the pistons and the oil is forced into the accumulator cylinder, further compressing the air in it and checking the recoil. A check valve prevents the fluid from returning, so that the gun is held in the position it had when it came to rest. In order to load, the gun must be brought to a horizontal position, and as the center of gravity of the gun is now considerably lower than the center of the "rocker carriage," this operation requires the raising of the weight of the gun for a foot or more, a rather slow and tedious operation. The gun must recoil a certain distance in order to allow the breechblock to be opened, and in case the recoil from the firing is not sufficient, a small hand pump, attached to the carriage for this purpose, can be used. The projectile is raised by means of a pulley at the side of the carriage and is swung around to the breech of the gun.

The object of the peculiar construction of the carriage is to bring the movement of recoil in the direction of the axis of the piece; and in this respect the system is superior to that of the spring-return carriage, both to prevent strain on the carriage and deflection of the projectile upward; but the construction of the Canet carriage is faulty in not allowing the breech to be opened in the firing position. Were the cheeks of the carriage wide enough in rear, the accumulator could be allowed to act immediately, after firing, to at once push the slides forward, and then the elevation of the breech for reloading could be accomplished without the preponderance above noted. The use of the hand pump would then be avoided.

32. Spring-return carriage for 12-inch breech-loading rifled mortar.—This carriage is the one that has been adopted for use in the service of the United States, and it was cast from gun iron at the Builder's Iron Foundry, Providence, R. I. The carriage consists of a base plate, or lower roller path, secured by wrought-iron bolts to the platform. This base plate is cast in a solid piece. Upon the base plate rests a ring of 24 forged steel conical rollers, protected from dust inside and out by easily removable guard plates. Upon the rollers rests the supporting plate of the carriage forming the upper roller path, and cast in one piece. Upon the supporting plate are bolted two side frames and a cross transom. These side frames carry the trunnion carriages with the recoil and spring-return apparatus. Cylinders for holding the springs to return the gun to battery are cast

as a part of these side frames, and continued down to the proper length by cylinders of gun iron bolted to the lower extremity by flanges. These cylinders are inclined at an angle of 50 degrees with the horizon. The trunnions of the gun rest in bearings formed in trunnion carriages of cast steel. These carriages embrace and slide upon guideways, formed upon the inner sides of the cylinders in the side frames. On the upper ends of the trunnion carriages are brackets projecting right and left into the spring cylinders and resting on the top of the springs. Piston rods are keyed to the lower ends of the trunnion carriages, and these work in two hydraulic recoil cylinders. The cylinders are bolted to the side frames and to the extensions of the spring cylinders. The elevating apparatus is attached to the trunnion carriages, and the gun is elevated and depressed by gearing acting on a circular rack. The mortar is held up in a firing position by the springs, filling the spring cylinders, and when it is fired it recoils down the sides until it is brought to rest by the action of the recoil cylinders. The springs then return it immediately to the firing position. The projectile is brought up for loading in the same manner as described for the 8-inch barbette carriage. Both car springs and Belleville springs have been used. The former are short and strong spiral springs of steel, experimented on with much success. The latter, tried with less success, are also of steel, saucer-shaped, but perforated in the center, and arranged in sets of two, base to base. They fill the cylinder, forming a column long enough to permit without injury sufficient compression to correspond to the recoil allowed by the hydraulic cylinders, on which the work of resistance comes, the springs being intended merely to return the mortar to its highest point, though incidentally they sustain some of the recoil.

It will be seen that the movement of the piece under recoil is in the direction of the axis of the bore only when the piece is fired at an elevation of 50 degrees, but the variation from this angle 15 degrees to 20 degrees on either side is not great enough to cause undue strain on the carriage.

33. Model of Sutcliffe's mechanism for breech-loading rifles.—Disk-shaped breechblock, supported by a pin attached to the front end of hollow breech screw, by the half revolution of which the block is lowered into a mortise in the body of the gun and the chamber exposed. On closing the screw sets up firmly against the block and transmits the strain to the walls of the breech. This has been applied to field as well as seacoast guns.

34. Model of Krupp's mechanism for breech-loading rifles.—The breech block moves transversely through a horizontal slot in rear of the chamber. The front face of the block is flat, and the rear surface a convex semicylinder whose axis is slightly inclined to the plane of the face. This avoids the sharp reentrant angles, and it has also

been found expedient to round the angles in front of the slot. The upper and lower surfaces of the slot contain guides which are parallel to the elements of the cylindrical surface, and which enters corresponding grooves in the block. The block thus receives a slight oblique motion which prevents friction between the Broadwell ring and the obturator plate, and also assists somewhat in pressing the cartridge home. A hole through the block permits the gun to be loaded when the block is withdrawn to the proper position. It is prevented from passing this point by a stop bolt screwed through the body of the gun and having a blank end projecting into a groove on the upper surface of the block. To secure the fermeture a revolving latch is employed. For small cannon using metallic ammunition this may be a simple turn button operated by an exterior handle and entering a recess in one of the faces of the slot. With a less perfect gas check means must be provided for pressing the obturator plate firmly against the obturating ring, so that in large guns the latch consists of a short, powerful screw. In order to facilitate the operation of the fermeture the fillets on one side of the newel of the screw are removed so that a half turn of the screw may engage or disengage the remaining fillets. For fieldpieces the block is withdrawn directly by hand, but heavy pieces are provided with a long screw contained in a groove in the upper part of the block and turning in two cylindrical collars, one at each end. The rotation of this serew in a half nut attached to the gun causes the block to move sidewise. The screw is cut with a considerable pitch to give rapidity of motion, but the auxiliary screw above described is used to start the block from its seat and to close it firmly.

35. Model of De Russy's depressing gun carriage, 1835.—This carriage was devised about the year 1835, by the late Brig. Gen. R. E. De Russy, Corps of Engineers. The top carriage rests in front on the eccentric axle of a pair of large wheels, the rear end resting on small wheels running on curved wooden braces. In the firing position the axle is in its highest position, and the small wheels on the highest point of the braces, the gun pointing over the parapet. As the gun recoils the wheels roll backward on cogged rails, carrying the axle to its lowest position, and the truck wheels move to the bottom of the braces, the recoil being partly taken up by a counterpoise of metallic spokes on the main wheels, opposite the axle, and partly by frictional appliances. The depression of the gun in recoil brings it under the shelter of the parapet from direct fire of the enemy and protects the gunners in loading. The gun is run into battery by a windlass and chain, the counterpoise assisting. It will be seen this carriage embodies the principle which Colonel Montcrieff employed later in the construction of his depressing carriage. Though this is a fieldpiece the model serves as a type of depressing or disappearing carriage, of which several samples have been tested, the King carriage, and the more

recent carriages for heavy guns, the Gordon and the Buffington-Crozier. From West Point.

36. Pneumatic dynamite gun.—This is represented only by its projectiles.

SIEGE GUNS AND CARRIAGES.

37. Five-inch breech-loading steel rifle mounted on siege carriage.—The gun consists of a central tube 138 inches long, a jacket 59.3 inches long, a trunnion band, which is shrunk over the recessed end of the jacket, 11.5 inches long, a tapering sleeve 16.2 inches long, and a screw or locking ring 5 inches long in front of the sleeve. In front of this for a distance of 65 inches the tube is unsupported to the muzzle. A base ring is screwed into the rear end of the jacket tightly against the end of the tube. The inside of this base ring is threaded and slotted for the breechblock. The whole length of the gun is 145.5 inches; weight 3,660 pounds, with some preponderance at the end of the breech. The rifling is uniform in twist, one turn in 35 calibers. The number of grooves and lands is 32. The powder chamber is cylindrical, terminated in front by a curved surface. The shot chamber, composed of a cylindrical and a conical surface, furnishes a place for the rear banded portion of the shot to rest, the forward part extending into the grooved portion of the bore, the band bringing up against the lands, which are beveled at their rear termination. The vent is axial through the obturator spindle. This siege gun is constructed very much like the field guns, the number of parts being the same and their arrangement nearly identical. The De Bange obturator is used as in the large guns and already described. The charge is 12¾ pounds of spherohexagonal powder, and the projectile weighs 45 pounds. The muzzle energy is 1,045 foot-tons, which makes the projectile capable of penetrating 6 inches of steel at the muzzle. The usual pressure per square inch in the bore is 35,000 pounds. One shot a minute can be fired. The carriage is without a limber, and it is intended to embody the more desirable features of the modern metal siege carriage, having the trunnions at a greater height from the ground and the weight as small as possible consistent with strength and durability. To insure the latter characteristic steel is principally used in the construction. The axis of the trunnions is 72 inches above a horizontal plane, upon which the carriage is supported when unlimbered, and the same axis is 10 inches in rear of the vertical plane containing the axis of the axles. When the carriage is limbered the center of gravity of the gun is directly over the axle, so that the center of gravity of the gun and carriage combined is between the two axles and a little above them. The length of the flasks is such that the distance from a line joining the points of support of the wheels to the line of support of the shoe plate is 100 inches. The carriage consists essentially of

two flasks, parallel throughout, connected by bottom and top plate and transoms. The parts of the flasks immediately under the trunnion beds are reenforced by two braces. The lower edges of the flasks and braces are flanged and connected by bolts with the axle plates, two in number. These plates embrace the axle closely, and are riveted together so as to form with the axle a strong, solid-built beam. The wheels, like those used on the field carriages, are of the Archibald pattern. They are 5 feet in diameter, with 16 spokes 3 inches thick, having a dish of 1.5 inches. The steel tire is 4 inches wide and five-eighths of an inch thick. The nave box, of malleable iron, is 16.5 inches long. The wheels weigh about 350 pounds each, and they are secured by linchpins with drag washers. The elevating apparatus is the double screw similar to those used with the field carriage. The recoil brake consists of a hydraulic cylinder, with throttling bar, attached to the trail and to a pintle fastened to the platform directly under the center of the axle. The total weight of the carriage is 2,820 pounds.

38. Seven-inch breech-loading steel howitzer.—The gun consists of a tube, base ring, jacket, trunnion band, split key-ring sleeve, and it has the De Bange breech mechanism. The tube is 86.9 inches long and it has a thickness of 2.23 inches over the powder chamber; forward of that to the extremity of the sleeve, 2 inches, except under the key ring, where it is but 1.6 inches; from the sleeve to the muzzle it tapers to a thickness of 1.5 inches. The chamber, including the seat for the De Bange gas check, is for 10.64 inches cylindrical, 7.2 inches in diameter. Thence for 2.4 inches it is conical, narrowing to 7.15 inches. A second cone, one-fourth of an inch in length, in which the bore contracts to 7 inches over the lands and 7.12 inches in the grooves, constitutes the beveled ends of the lands and the surface for centering the banded projectiles, and serves to connect the chamber with the rifled portion of the bore. The rifling is uniform, one turn in 35 calibers. A shoulder locking in the jacket prevents a thrust of the tube to the front; a key ring in front of the trunnion band under the sleeve, in addition to the friction due to shrinkage, prevents the jacket and tube from being thrust to the rear by the action of the powder on the breech block transmitted through the base ring to the jacket. The jacket is cylindrical on the exterior, with a thickness of 2.42 inches for a portion of its length, and for the remaining portion 2.75 inches. The trunnion band is cylindrical on the exterior, excepting the rim base and trunnions, with a thickness of 3.25 inches. The sleeve is 2 inches thick except over the key ring and in front for 4½ inches, when it is reduced gradually to prevent an abrupt change in the form of the exterior of the piece. The gun weighs 3,710 pounds, the charge of granular powder is 10 pounds, and the weight of the projectile is 105 pounds. The muzzle velocity is 1,085 feet per second and the extreme range is about 6,000 yards.

The carriage for the 7-inch howitzer (not exhibited) is in appearance somewhat similar to that of the 5-inch siege gun. The trunnions of the gun are carried in small independent slides, which are constrained to move on the rails formed by the edges of the flasks, these rails being inclined to the rear and downward at an angle of 20 degrees. Pistons attached to the front of these slides work in cylinders fixed to the front of the rails. In rear each slide is supported by a course of Belleville springs, which return the gun into battery after the energy of recoil has been absorbed by the recoil cylinders. The gun is elevated by means of a circular rack with properly arranged toothed gearing operated by a hand wheel in rear. The recoil of the carriage is taken up by a recoil cylinder attached to the trail, similar to that used with the siege carriage.

FIELD GUNS AND CARRIAGES.

39. 3.6-inch breech-loading steel rifle on field carriage.—This gun is built up of a tube extending through the whole length of the gun and a jacket over the rear part, the jacket having the trunnions forged on at the front end, a locking ring held in place by a sleeve securing the front of the jacket to the tube. The tube is 83.7 inches long. The jacket is shrunk on the tube, extending forward 34.6 inches and abutting at its front end against a shoulder on the tube. The locking ring, split in halves, fits in recesses in the tube and the front of the jacket, and over this is shrunk a sleeve 6.2 inches long, abutting against a shoulder near the front of the jacket. From the sleeve to the muzzle, a distance of 43.9 inches, the tube is unsupported. The chamber is cylindrical, very similar to that of the 3.2-inch field gun described hereafter, and the breech mechanism is the same. The rifling is a semicubic parabola, from one turn in 50 calibers to one turn in 25 calibers. The charge of powder is 4¼ pounds and the projectile weighs 20 pounds. The muzzle velocity is about 1,550 feet per second. The gun weighs 1,181 pounds and the total length is 7.79 feet. This gun is shown on a 3.2-inch gun carriage of steel, strengthened for the purpose. A description of this carriage is given below.

40. 3.2-inch breech-loading steel rifle on field carriage, with limber, horses, and harness.—This gun is built up with a central tube, 85.2 inches long, varying in exterior diameter from 6 inches to 4.6 inches near the muzzle; and a jacket, length 25.9 inches, maximum diameter 9.56 inches, which is shrunk over the rear part of the tube, a shoulder on which prevents the jacket from working forward. The rear end of the tube abuts against a base ring, screwed inside of the jacket, which projects beyond the tube at the rear. The French, or "slotted screw," breechblock works in this base ring. In front of the jacket, and bound to it by an overlapping locking joint, is the trunnion hoop shrunk on to the tube. Its width between rim bases is 9.5 inches, and its length

8.8 inches. In front of the trunnion hoop, and bearing close against it, is the "sleeve," shrunk on to the tube—maximum diameter, 6.8 inches; minimum, 6.6 inches; length, 13.3 inches—and in front of that is the key ring, which is screwed on to the tube, and set firmly against the sleeve; diameter of key ring, 6.5 inches; length, 3 inches. In front of that the tube is unsupported for a length of 38.7 inches to the muzzle. All the parts are thus bound securely together by shoulders and screw threads in a manner which presents no greater difficulty of construction than the shrinkage of plain, superposed clinders usually offers. The powder chamber is cylindrical; the shot chamber, composed of two inclines and a straight surface, furnishes a place for the copper band at the rear end of the shot to rest, the forward end of the shot extending into the groove part of the bore, the band bringing up against the lands, which are beveled at their rear termination. The vent is radial over the middle of the chamber. A sliding vent cover, extending to the rear and operated by the hinged handle of the breech screw, prevents insertion of the primer except when the breech is closed securely. The rifling is a semicubic parabola, with a twist of from one turn in 50 to one turn in 35 calibers, or an angle of 6 degrees. There are twenty-four grooves and lands. The total length of the piece is 90.7 inches; weight, 805 pounds; preponderance at end of breech, 57 pounds.

Breech mechanism: The breechblock, 6.45 inches long by 4.47 inches in diameter, is threaded and slotted, three sections being plain and three with threads. The base ring in which it works is threaded and slotted correspondingly. One-sixth of a turn, therefore, serves to lock or unlock the block when in its place. The last or rearmost thread on the block is not cut away, and this serves the purpose of closing the rear face of the breech against dirt and wet, and acts as a stop for the block when it is pressed into place. The block is held in a swinging carrier ring, 1.2 inches thick, hinged at the left side, which allows the block to be swung to the left when drawn out, and guides the block in entering the breech on closing, allowing the block to be freely turned. It serves, when closed, to fill the space between the jacket and the block. This ring is automatically locked to, and unlocked, by the motion of the block acting on a key-pin. The lever handle for turning the block, and the bronze handle for withdrawing it, are fastened to its rear end. When the lever handle is turned down, after closing the breech, it locks the breechblock from turning.

The De Bange (French) gas check, described under the 12-inch breech-loading steel mortar, is now used with this piece, having replaced the Freyre (Spanish) obturator formerly used. For convenience of reference the Freyre gas check is here described.

The Freyre obturator, or gas check, placed in front of the breechblock, terminates in a head shaped like a truncated cone, small end

toward the rear. A gas-check ring of highly elastic steel, formed to fit the cone surface on the inside, but nearly cylindrical on the outside, surrounds this head and rests against the breechblock. The head is not in contact with the block, but nearly so, and the distance can be increased or diminished by the nuts screwed on to the rear end of a spindle which passes through the center of the breechblock. A strong spring intervenes to keep the head away from the face of the block, except when the great pressure of the powder gases presses it home, expanding the elastic ring against the walls of the powder chamber, and effectually cutting off all escape of gas. When the pressure is removed the spring forces the head forward and the ring is allowed to contract. The expansion of the gas check can thus be regulated to suit the character of the steel in the gas-check ring. The Freyre gas check closely resembles that used in the Williams rapid-fire gun, elsewhere described. The latter differed only in having a split ring instead of a continuous ring, the conical rear surface of the head acting in the same manner to expand the ring. The Freyre system may therefore be considered an American invention, as is the case with the slotted screw breechblock itself.

The record of the gun is as follows: Initial velocity of projectile, 1,685 feet; extreme range, about 3½ miles; charge of powder, 3¾ pounds; weight of shell, 13½ pounds; pressure of powder gases in gun, 35,000 pounds per square inch. Some firings have been made with the 3.2-inch gun at the proving ground, using French smokeless powder. A charge of 1 pound and 14 ounces of this powder with a 13.5-pound shell, gave a velocity of about 1,680 feet and a pressure of only 21,000 pounds. The charge with black hexagonal powder is 3½ pounds for the same velocity and the pressure about 35,000 pounds. Some firings have also been made with a smokeless powder of American manufacture, and the results, for a first attempt, are considered promising.

41. Carriage, limber, and caisson for field guns.—A steel carriage of the following construction is used for both the 3.6-inch gun and the 3.2-inch gun: The principal parts are the two flasks, connected by transoms and the lunette; the two axle plates, upper and lower; the axletree; the wheel brakes; the wheels; the elevating apparatus, and the seats and steps. Each flask is formed by riveting together two plates with curved margins. The cross section of the margin from the vicinity of the trunnion beds to the tool box is approximately semicircular; the center of the semicircle being in the plane of the inner surface of the plate. The cross section varies for the inner and outer plates, as the margin of the latter is prolonged in a direction tangent to the circle until it envelops the margin of the former for a portion of its length. The formation of this curved margin by a single stroke illustrates a remarkable use by Colonel Buffington of the

drop hammer for very heavy work. Two large cast-iron dies are used, shaped to give the outer and inner curves required. The plate, cut to proper shape and heated, is placed on one die, and the other is dropped upon it by means of a steam hammer. The trunnion beds are reenforced by bars of steel, which are inclosed between the margins of the flask plates and riveted to them. There are three front transoms—upper, lower, and rear—in the vicinity of the trunnion beds and axle plates, and three trail transoms at intervals between the axle plates and the lunette. The axle plates, two in number, which envelop the axletree, are made from plates formed by dies under a steam hammer. To insure an accurate fit these plates are planed, bolted together, and bored out. The axletree having been turned to a true cylinder, the plates are riveted about it. The shoulder washers are octagonal in form; to each is fitted a collar or band containing a stout eye, to which the brakes are attached. These collars have projections that embrace the axle plates above and below to prevent the turning of the axle within the plates. The brakes supplied with this 3.6-inch carriage are formed like a double-bow spring, and furnished with a device for detaching them, if necessary, when the wheel is locked. The brakes on the 3.2-inch carriage have spiral springs concealed within. One end of the brake is attached to the eye on the axle collar, and the other end has a projecting shoe which hooks over the tire of the wheel. The elevating apparatus for the 3.6-inch gun is that which was used with the carriage constructed at Watervliet Arsenal. The elevating screw guide is secured to the under side of the upper front transom. A later form, introduced by Colonel Buffington, gives the elevation by means of lazy tongs, operated by a vertical screw. This form, used for the 3.2-inch gun, does not require any projection below the carriage, and the carriage is so constructed in other respects as to leave a clear space below the level of the axles to pass over obstructions without touching. The total weight of the carriage complete, including steps, wheels, and brakes, is 1,304 pounds. The limber has a steel body with wooden ammunition chest opening at the top like the present ammunition chests, steel chests opening in rear being found by experiment to be undesirable. The inside dimensions of chest are: Length, 42¾ inches; width, 24 inches, depth, 9 inches. It is divided into three compartments, the end ones 10 inches wide, for 21 projectiles in each; the middle one for cartridges, 42 in number. Projectiles stand on their bases, in square compartments, separated by copper plates. The points of the projectiles are held in place by the cover when closed. A chest filled with dummy projectiles and cartridges is shown with the gun and carriage. The caisson body will be of steel, and will serve also for the traveling forge, chests for the forge being of the same dimensions as the ammunition chest. A portable forge is made of dimensions to fit in this chest. Instead of bellows, a blower is used, operated by a crank.

42. New harness for light-artillery and machine guns.—A full set of wheel and lead harness, devised by Brevet Lieut. Col. E. B. Williston, major Third Artillery, is shown on lay horses. It differs materially from artillery harness previously used. The saddle and equipment of cavalry are adopted in place of the old, and the harness is made to conform more closely to the ordinary draft harness used for wagons. It is constructed with a view to celerity and ease in harnessing and unharnessing. The pole yoke is given up, and a neck yoke is adopted. In place of the rigid splinter-bar, a swinging doubletree is used, with singletrees attached, to equalize the draft of the two horses. The singletree is placed above the pole for light draft, and below it for heavy loads. To unhitch, it is only necessary to unhook the singletrees from the doubletrees, and slip the ring of the neck yoke off the end of the pole. The singletrees can be then attached to hooks on the cantle of the saddle. Instead of a single lead line for the off horse the bridle has two reins which unite in a single strap passing over a roller on the saddle and hanging on the side toward the driver, where he can readily grasp it. Wide and thin traces are used instead of the present thick, narrow trace. The collar is hinged at the top and fastened at the bottom by a spring fastening. Martingale and side straps are used to hold the neck yoke down and relieve strain in holding back. A woven-hair pad is recommended. The new harness is much lighter than the old system. It is claimed that this harness is much more convenient in harnessing and unharnessing, and that it can be manufactured more cheaply than that now in use; also, that its adjustment can be more readily learned by civilians called to act as teamsters.

43. Williston's sectional picket rope for light artillery.—This consists of several lengths of rope, each length provided with steel shoes at the ends, one holding a link and the other a hook. The link is made thin enough at one side for the hook to slip on, the rest of the link being large enough to keep the hook from slipping off. The lengths can be readily joined by these fastenings, each wagon carrying one length, enough for the horses belonging to it when detached from the rest of the battery. The rope is laid along the ground and secured to it by iron picket pins having two hooks at the end to overlap the rope from opposite sides. Any section can be used as a prolonge, if desired, for the gun carriage.

44. 3.6-inch breech-loading steel mortar and carriage on mortar platform.—This is a short rifled piece intended for vertical fire, chiefly against the personnel of the enemy, to reach troops protected by intrenchments or inequalities of the field from the direct fire of field guns. It takes the place in service of the Coehorn smooth bore mortar, being much more powerful, accurate, and far-reaching than that piece. The mortar weighs 244 pounds, and it is 24.8 inches long. The maximum charge of powder is 1 pound, and with this charge the

range of the 20-pound projectile is 3,500 yards. It fires the same projectiles as the 3.6-inch field gun. The total length of bore is 18.9 inches, and of the rifled portion of the bore 14.4 inches. It is rifled with 24 grooves, having a twist varying from one turn in 40 calibers to one turn in 25 calibers at the muzzle. The field of fire with shell and shrapnel will embrace all ranges from about 300 to 3,500 yards, using reduced charges of powder for the shorter ranges. The initial velocity with the maximum charge is about 677 feet per second, and the pressure in the bore is about 18,000 pounds per square inch. In construction the mortar is made of a single piece of steel, forged, oil-tempered, and annealed, and having the trunnions forged solid with the piece. The breech mechanism is in general similar to that of the field piece, except that the vent is axial and that in the locking arrangement the lever handle of the field-gun mechanism is replaced by a bolt which is turned by a T handle. This bolt carries a vent cover, which keeps the vent closed when the breech is unlocked. This is the only piece now fitted with the Freyre obturator, the De Bange being adopted for all other guns not using metallic cartridge cases. A projecting stud in the base of the breech actuates the locking piece of the carrier ring. The carriage or mortar bed, with transoms and soles complete, is cast of steel in one piece, and it weighs about 275 pounds. In firing this carriage rests upon a wooden platform, which is secured to the ground with a slight inclination upward to the rear, and the carriage is attached by ropes to a post set into the ground, so that the piece can not recoil from the platform. There is a pintle in the platform against which a front recess on the carriage is brought to bear before each round, merely giving a center of motion for traversing the carriage in aiming. A pointing scale is also used for giving lateral variations and making corrections for each shot from data furnished by the preceding shots. This scale is a square rod of hard wood having a side pivot at one end, which can be inserted in a socket let into the platform on the axial line in the rear, and can be swung to either side to measure the distance on a scale of cords to the rear end of either cheek of the carriage for the purpese of fixing the direction of the mortar with great accuracy to correspond with any desired lateral change in aim. The scale is graduated on one side, the unit of the scale being one one-thousandth of the range, and each division one five-hundredth of the range. A brass index slide moves with friction along the length of the scale, and it is clamped by a screw when regulated. For reference marks a brass screw is placed at the end of each cheek of the carriage. The carriage admits of a motion around its pintle of about 15 degrees on either side of the axis of the platform. The elevation is given by a quadrant. Trials at the 1,000-yard target show that the mortor can be pointed with considerable precision to give a lateral variation of 15 yards in firing.

45. Hotchkiss breech-loading mountain gun, caliber 1.65 inches, and carriage packed on pack mules.—This gun having been devised especially with reference to mountain service, it is made as light as practicable. It weighs only 116 pounds, and one man is able to place it upon the back of a mule. The weight of the carriage being but 220 pounds, the packing, unpacking, and mounting of the gun and its carriage require only two men. For transportation, the material is distributed as follows: The first animal carries the gun and wheels; the second animal carries the gun carriage, draft harness, pole or shafts, splinter bar, pole yoke, and gunner's pouch; the third animal carries 6 ammunition boxes containing 72 rounds. The weight on the first animal, including saddle and fastening, is 291 pounds; on the second animal, 237½ pounds; and on the third animal, 309½ pounds. The exhibit illustrates the construction of the pack saddles and the method of packing. The construction of the gun is based upon the use of a metallic cartridge, by which the obturation of the breech is accomplished. The extraction of the cartridge case is effected automatically by the opening of the breech. The gun is made of Whitworth steel compressed in the fluid state. The mechanism of the breech consists simply of a prismatic bolt with a cam, entering a cavity recessed in the breech. The cartridge extractor is a simple prismatic piece of metal, bearing at its forward extremity a hook; it is guided in a cavity in the upper part of the breech, parallel to the axis of the piece. On its lower face is fitted a tenon, which slides in a groove cut in the upper face of the breechblock. The groove is straight on the side toward the handle, but curved at the other extremity, so that in withdrawing the breechblock the tenon of the extractor slides for a time in the straight part of the groove; but as soon as the block is so far withdrawn that the opening for charging comes against the face of the chamber the tenon becomes engaged in the inclined portion of the groove, and is suddenly drawn backward, by which motion the empty case is thrown out of the gun. The powder is contained in a metallic cartridge case made either of wrapped metal or with a soldered joint. Through the center of the iron head of this case is a flame hole, closed with an internal valve, which is lifted by the flame from the friction primer, but is closed by the pressure of the gas within the bore when the cartridge is fired. The friction primer is inserted in a vent in the rear of the breech housing, and the vent is prolonged obliquely through the breechblock. A wide band of thin brass encircles the projectile and this is forced into the rifling to give rotation. The carriage is of steel and of simple construction, the cheeks being two flanged plates, joined together by the trail plate, an inclined plate through which the elevating screw passes, and an inclined plate under the body of the piece. Capt. Frank D. Baldwin, Fifth United States Infantry, has devised an ingenious carriage for this gun. It is fashioned somewhat like a mortar bed with cheek pieces but no chassis. The

lower parts of the cheeks can be turned outward, swinging on a horizontal hinge, to fit on an aparejo, so that the gun and carriage can be packed together on one mule for transportation. This saves the use of one mule in service where it is not intended to haul the gun. The charge of powder is 269.5 grains and the shot weighs about 2 pounds.

A 3-inch breech-loading Hotchkiss mountain gun has been made and tested with satisfactory results. This piece was designed to fire fixed ammunition; but to meet the needs of service requiring the use of full and half charges, it is proposed to separate the projectile from the cartridge case, and load them separately into the gun. The cartridges will then be put in the case in two half charges, one of which can be readily removed when it is desired to fire with one-half charges only. The charge is ignited by a friction primer. The piece is mounted on a two-wheel carriage and provided with a limber for traveling purposes and for transportation of ammunition. The weight of the charge is 11 ounces, and the projectile weighs 12 pounds.

46. Yates breech-loading field gun, not mounted.—The principal feature of this gun is the breech mechanism, which was invented by Colonel Yates, a retired officer of the Army. It is novel in principle and in application. It consists of a couple of concave clamps (half sections), which, when closed, embrace the breech of the gun exteriorly, and are intended to afford longitudinal support to a solid head cartridge case, or whatever may be used within the breech end of the tube for the actual gas sealing device, which is entirely independent of the breech-loading mechanism, and not to be understood as forming a part of it. The clamps form a shell or envelope for the entire breech of the gun, divided into two equal parts or sections, which meet in a vertical plane through the axis of the gun. The two clamps are hinged in common, well forward on the reinforce of the gun, and grooves or shoulders are cut circumferentially on the interior of the clamps. These shoulders, when the clamps are closed, hook upon corresponding shoulders cut around the reinforce of the gun, and afford longitudinal support to the clamps. A hinged shutter, flat in front and rounded in rear, forms an inner cover to the breech, to serve as a support to the cartridge shell, and it carries a shell extractor to extract the shell in opening. The clamps come to a close bearing over the breech end of the tube, to support the shutter, and they open wide enough to uncover a little more than the diameter of the bore at the breech and allow the shutter to be swung downward. The opening and closing is done by means of a lever attached to the under side of the breech of the gun, pins on either clamp working in grooves cut in the lever. The vent is axial through a tube projecting through the clamps from the rear of the shutter.

47. Models of Gerdom breech mechanism for field guns.—These models show a new form of interrupted screw breech mechanism, with

only two threaded sections on the breechblock. One model has the mushroom head with gas check pad and cups of the DeBang system for checking the gas, while the other has the front of the breechblock flat, and has an extractor for use with metallic cartridge cases. The breech of the gun is slotted on the left side for a distance equal to about the length of the breechblock, and in this slot, hinged at the forward extremity, swings a carrier block, to which is rigidly attached a carrier ring in which the breechblock turns. The breechblock is planed off on two opposite sides, and is threaded between these surfaces to engage, when closed, with threads cut at top and bottom in the breech of the gun. To open the breech, the breechblock is rotated for a quarter of a turn, disengaging the screw threads and bringing the flat surfaces horizontal. Then the carrier block is swung to the left out of the way of the bore. This saves one of the motions of the ordinary screw mechanism, that of drawing back the breechblock. The mechanism with mushroom head has an axial vent and a safety vent-closing device worked automatically in the closing of the breechblock. The other device hasa firing pin, which is cocked ready for firing when the breech block is opened, and is fired by a lanyard. There is an extractor sliding in grooves on the left side of the bore of the breech, which is engaged by a lug on the hinge of the carrier block when the block is about three-quarters open. The former mechanism has been successfully tried on a 3.2 breech-loading field gun.

The following table gives data concerning all the breech-loading guns adopted in the United States service for land defense:

United States Army breech-loading cannon, 1892.

Weights, dimensions, etc.	Mountain artillery.		Field artillery.			
	Hotchkiss 1.65-inch B. L. rifle, steel.	Hotchkiss 3-inch B. L. rifle, steel.	3.2-inch B. L. rifle, steel, model 1885.	3.2 inch B. L. rifle, model 1890.	3.6-inch B. L. rifle, steel, model 1891.	3.6-inch B. L. mortar, steel, model 1890.
Weight ..... pounds..	121	218	829	805	1,181	244
Weight ..... tons....						
Total length ..... feet..	3.88	3.76	7.56	7.81	7.79	2.05
Length of bore..... calibers..	25.38	13.48	26.0	25.2	23.5	5.19
Maximum diameter of breech, inches.....	5.03	6.7	9.56	9.0	9.8	7.8
Diameter of muzzle ...inches..	2.55	3.94	5.1	5.0	6.0	5.4
Diameter of trunnions. ..do....	1.8	2.56	3.8	3.8	3.8	3.8
Length of trunnions.....do....	1.8	2.44	2.25	2.7	3.0	2.5
Distance between rim bases, inches.....	4.7	7.09	9.5	9.5	9.5	9.5
Distance of axis of trunnions from muzzle.....inches..	27.3	26.5	60.4	57.719	57.25	14.6
Rifling:						
Number of grooves.....	10.0	24.0	24.0	24.0	26.0	20.0
Width of grooves ..inches..	0.36	0.276	0.3	0.3	0.3162	0.4454
Depth of grooves ....do....	0.012	0.026	0.05	0.04	0.04	0.045
Width of lands .....do....	0.157	0.117	0.1188	0.1188	0.1188	0.12
Twist of rifling...calibers..	1 in 29.83	1 in 25.59	1 in 30	1 in 50.0 to 1 in 25.0	1 in 50.0 to 1 in 25.0	1 in 40.0 to 1 in 25.0
Powder chamber:						
Diameter.....inches..	1.8	3.161	3.8	3.6	3.9	3.8
Length .....do....	4.6	3.73	11.508	10.7	12.275	2.835
Capacity ....cubic inches..	11.71	27.12	109.7	110.3	149.2	33.2
Total capacity of bore, cubic inches.....	93.6	292.0	714.7	689.3	894.5	200.2

United States Army breech-loading cannon, 1892—Continued.

Weights, dimensions, etc.	Mountain artillery.		Field artillery.			
	Hotchkiss 1.65-inch B. L. rifle, steel.	Hotchkiss 3-inch B. L. rifle, steel.	3.2-inch B. L. rifle, steel, model 1885.	3.2-inch B. L. rifle, model 1890.	3.6-inch B. L. rifle, steel, model 1891.	3.6-inch B. L. mortar, steel, model 1890.
Powder charge:						
Kind of powder	Mortar.	IK Granular.	UR sphero-hex.	UR sphero-hex.	UR sphero-hex.	UR sphero-hex.
Weight of charge..pounds..	[a]5.5	[a]14.0	3.5	3.5	4.1875	[a]15.0
Density of loading	0.8127	0.9	0.8832	0.8783	0.7769	0.8339
Projectile:						
Weight of projectile (filled) pounds	1.95	12.0	13.5	13.5	20	20
Ratio of weight to weight of piece	$\frac{1}{63}$	$\frac{1}{19}$	$\frac{1}{61}$	$\frac{1}{85}$	$\frac{1}{85}$	$\frac{1}{12}$
Weight of bursting charge, pounds	[a]1.8	[a]6.3	[a]7.25	[a]7.25	[a]14.5	[a]14.5
Length of projectile, calibers	3.5	3.5	3.0	3.0	3.25	3.25
Sectional density $=\frac{W}{d^2}$	0.7163	1.3333	1.3183	1.3183	1.5432	1.5432
Travel of projectile, in bore, calibers	22.56	12.243	22.5	21.81	20.08	4.47
Muzzle velocity..foot-seconds..	1,298	870	1,685	1,685	1,550	650
Pressure per square inch in powder chamber ...pounds..		14,560	35,000	35,000	35,000	16,000
Muzzle energy .....foot-tons..	22.8	63.0	265.7	265.7	333.1	58.6
Penetration in steel at—						
Muzzle .....inches..	1.3	1.4	3.8	3.8	3.9	1.1
1,000 yards.....do....						
2,500 yards.....do....						
3,500 yards.....do....						
Forgings:			1,397	1,292	1,803	319
Total weight .....pounds..						
Weight of tube .....do....			622	624	838	277
Weight of jacket ....do....			426	583	855	

Weights, dimensions, etc.	Siege artillery.			Seacoast artillery.	
	5-inch B. L. rifle, steel, model 1890.	7-inch B. L. howitzer, steel, model 1890.	7-inch B. L. mortar, steel, model 1892	8-inch B. L. rifle, steel, model 1888, M.	10-inch B. L. rifle, steel, model 1888, M.
Weight.....pounds..	3,660	3,710	1,715	32,480	67,200
.....tons....				14.5	30.0
Total length.....feet..	12.15	8.475	4.86	23.21	30.60
Length of bore .....calibers..	27.0	12.67	7.0	32.0	34.0
Maximum diameter of breech, inches	15.0	16.7	13.8	30.0	38.5
Diameter of muzzle ....inches..	8.0	10.0	10.5	14.0	16.8
Diameter of trunnions ...do....	5.8	7.0	7.0	10.0	12.0
Length of trunnions .....do....	3.3	4.0	4.0	6.0	6.75
Distance between rim bases, inches	15.0	18.0	14.3	32.5	42.0
Distance of axis of trunnions from muzzle .....inches..	96.25	64.87	34.15	183.0	243.6
Rifling:					
Number of grooves	30.0	42.0	28.0	48.0	60.0
Width of grooves ..inches..	0.3736	0.3736	0.6354	0.3736	0.3736
Depth of grooves.....do....	0.05	0.05	0.055	0.06	0.06
Width of lands.....do....	0.15	0.15	0.150	0.150	0.150
Twist of rifling ...calibers..	1 in 50.0 to 1 in 25.0	1 in 50.0 to 1 in 25.0	1 in 40 to 1 in 15	1 in 50 to 1 in 25	1 in 50 to 1 in 25
Powder chamber:					
Diameter .....inches..	5.7	7.2	7.25	9.5	11.8
Length.....do....	15.15	7.465	4.18	50.75	65.09
Capacity.... cubic inches..	395.6	315.7	182.8	3,597	7,064
Total capacity of bore, cubic inches	2,824.5	3,520.1	1,950.9	14,125	28,977
Powder charge:					
Kind of powder	IB sphero-hex.	IK granular.	IB sphero-hex.	UR brown pris.	VU brown pris.
Weight of charge..pounds..	12.5	10.0	5.5	125.0	250.0
Density of loading	0.8746	0.8768	0.8328	0.9619	0.9797
Projectile:					
Weight of projectile (filled), pounds	45	105	125	300	575

[a] Ounces.

United States breech-loading cannon, 1892—Continued.

Weight, dimensions, etc.	Siege artillery.			Seacoast artillery.	
	6-inch B. L. rifle, steel, model 1890.	7-inch B. L. howitzer, steel, model 1890.	7-inch B. L. mortar, steel, model 1892.	8-inch B. L. rifle, steel, model 1888, M.	10-inch B. L. rifle, steel, model 1888, M.
Projectile—Continued.					
Ratio of weight to weight of piece	$\frac{1}{31}$	$\frac{1}{35}$	$\frac{1}{32}$	$\frac{1}{108}$	$\frac{1}{117}$
Weight of bursting charge, pounds	2.58	9.8	12.5		
Length of projectile, calibers	3.0	3.0	3.6	3.5 4.5	3.5 4.5
Sectional density=$\frac{W}{d^2}$	1.8000	2.1428	2.1428	4.6875	5.7500
Travel of projectile, in bore, calibers	23.96	11.61	6.40	25.66	27.51
Muzzle velocity..foot-seconds	1,830	1,085	690	1,950	1,975
Pressure per square inch in powder chamber....pounds	35,840	28,224	18,000	37,000	37,000
Muzzle energy.....foot-tons	1,045.0	856.9	412.5	7,907.5	15,548
Penetration in steel at—					
Muzzle.....inches	6.2	3.8	2.2	16.0	20.4
1,000 yards.....do	4.6	3.2		14.2	18.5
2,500 yards.....do	3.0	2.7		11.9	16.0
3,500 yards.....do	2.5	2.4		10.6	14.6
Forgings:					
Total weight.....pounds	5,543	5,722	2,206	39,674	82,664
Weight of tube.....do	2,421	2,225	1,982	9,632	18,945
Weight of jacket.....do	2,031	1,224		9,712	18,115

Weights, dimensions, etc.	Seacoast artillery.				
	12-inch B. L. rifle, steel, model 1888, M.	12-inch B. L. rifle, steel, model 1891.	16-inch B. L. rifle, steel, model 1892.	12-inch B. L. mortar, cast iron, hooped with steel.	12-inch B. L. mortar, steel.
Weight {pounds	116,480	128,719	280,000	31,920	29,120
Weight {tons	52.0	57.5	125	14.25	13.0
Total length.....feet	36.66	40.0	49.67	10.75	11.76
Length of bore.....calibers	34.0	37.83	35.0	9.0	10.0
Maximum diameter of breech, inches	46.2	46.4	62.0	41.75	38.0
Diameter of muzzle....inches	20.2	19.8	27.0	22.5	21.0
Diameter of trunnions...do	14.5	14.5		12.0	12.0
Length of trunnions.....do	8.0	8.0		6.0	8.0
Distance between rim bases, inches	50.2	50.2		44.0	40.0
Distance of axis of trunnions from muzzle.....inches	291.10	318.1	396	79.1	90.125
Rifling:					
Number of grooves	72.0	72.0	96.0	68.0	72.0
Width of grooves..inches	0.3736	0.3736	0.3736	0.379	0.3736
Depth of grooves.....do	0.06	0.06	0.07	0.07	0.06
Width of lands.....do	0.150	0.150	0.150	0.175	0.150
Twist of rifling...calibers	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 40 to 1 in 25	1 in 40 to 1 in 20
Powder chamber:					
Diameter.....inches	14.2	14.5	18.8	12.4	12.5
Length.....do	77.33	78.58	106.06	15.75	20.8
Capacity.....cubic inches	12,114	12,798	29,341	1,990	2,636
Total capacity of bore, cubic inches	50,049	55,829	121,487	12,554	13,947
Powder charge:					
Kind of powder	VP brown pris.	Brown pris.	Brown pris.	VM brown pris.	VM brown pris.
Weight of charge..pounds	450.0	487.0	1,060	80.0	105.0
Density of loading	1.0285	1.0585	1.000	1.1128	1.1026
Projectile:					
Weight of projectile (filled) pounds	1,000	1,000	2,370	[a] 800 1,000	800 1,000
Ratio of weight to weight of piece	$\frac{1}{118}$	$\frac{1}{118}$	$\frac{1}{118}$	[b] $\frac{1}{70}$	[b] $\frac{1}{88}$

[a] The 1,000-pound 12-inch mortar shell may be used for ranges up to 2½ miles, with reduced charges; the 800-pound shell will be used for greater ranges and the maximum charge.

[b] For 800-pound shell.

United States Army breech-loading cannon, 1892—Continued.

Weights, dimensions, etc.	Seacoast artillery.				
	12-inch B. L. rifle, steel, model 1888, M.	12-inch B. L. rifle, steel, model 1891.	16-inch B. L. rifle, steel, model 1892.	12-inch B. L. mortar, cast iron, hooped with steel.	12-inch B. L. mortar, steel.
Projectile—Continued.					
Weight of bursting charge, pounds				20.8 37.5	20.8 37.5
Length of projectile, calibers	3.5 4.5	3.5 4.5	3.5 4.5	3.0 3.8	3.0 3.8
Sectional density=$\frac{W}{d^2}$	6.9445	6.9445	9.2578	[a] 5.5556	[a] 5.5556
Travel of projectile in bore, calibers	27.58	31.29	28.37	7.66	8.225
Muzzle velocity..foot.seconds..	1,975	2,100	1,975	[a] 1,020	[a] 1,140
Pressure per square inch in powder chamber....pounds..	37,000	38,000	37,000	27,500	30,000
Muzzle energy .....foot-tons..	27,040	30,570	64,084	5,769.7	7,206.9
Penetration in steel at—					
Muzzle.....inches..	24.9	27.1	33.8	[a] 8.2	[a] 9.7
1,000 yards.....do....	23.0	25.1	31.9	.....	.....
2,500 yards.....do....	20.4	22.3	29.2	.....	.....
3,500 yards.....do....	18.7	20.6	27.5	.....	.....
Forgings:					
Total weight.....pounds..	140,578	152,860	336,000	[b] 36,220	34,884
Weight of tube.....do....	82,490	36,054	.....	21,178	7,666
Weight of jacket.....do....	31,249	34,374	.....	.....	9,840

[a] For 800-pound shell. [b] Including cast-iron body.

ORDNANCE OFFICE, U. S. A.,
Washington, D. C., May 25, 1893.

RAPID-FIRE GUNS.

48. Williams rapid-fire gun, rifled, caliber 1.56 inches.—Though used in the war of the rebellion, this corresponds to the class of quick loaders, now exemplified by the Hotchkiss, Seabury, or Driggs-Schroeder rapid-fire guns, the latter, however, having the great advantages of using self-primed metallic-case ammunition, to which the Williams gun might readily be adapted for use with moderate calibers. The Williams gun has a breechblock moving back and forth in the line of the barrel. It is operated by turning a crank on the right side. Upon the crank shaft, which is perpendicular to the axis of the bore, is an eccentric which alternately withdraws and pushes in the breechblock to open and close the breech. A worm at the end of the shaft works on the end of the lever at the left side of the piece, the lever having a hammer at the other end. When the end of the worm is reached, the hammer thus raised is released and forced by a spring against a nipple on which a percussion cap is placed. The mechanism is so arranged that just after the breechblock is closed the hammer falls and fires the piece. The breechblock is supported against the shock of the discharge by the eccentric, which transfers the strain to the shaft upon which it revolves. The gas check used in the Williams gun closely resembles the Spanish Freyre gas check used in the new United States breech-loading field mortar, and formerly used with the 3.2-inch field piece. The inventor, Mr. D. R. Williams, of

Covington, Ky., took the gun South at the beginning of the rebellion, and it was adopted by the Confederate Government. Some of the batteries are said to have done much execution. The inventor claims to have fired 65 shots per minute. In operation of breech mechanism it most nearly resembles the Gardner gun described under machine guns.

49. Hotchkiss 6-pounder rapid-fire gun.—The body of the gun consists of three pieces of oil-tempered steel—the tube, extending from the face of the muzzle to the front face of the breechblock, comprising the whole length of the bore; the jacket, which is shrunk over the rear part of the tube and which carries both the trunnions and the breechblock; the locking ring, a screwed collar connecting the tube and jacket and which carries the fore-sight mass. By this construction the tube bears the main traverse strains, the jacket bears all the longitudinal strains, and the locking ring insures against the displacement of the tube and jacket. The bore is rifled with an increasing twist, and the lands, 24 in number, are very narrow in proportion to the grooves. The breechblock is a square hollow steel block with rounded corners, having a vertical motion in a mortise, cut completely through the jacket. The front face of the block is perpendicular to the axis of the bore, while the rear face is slightly inclined. The front upper corner is cut back to allow free movement to the extractor. In the hollow part of the block is contained the firing mechanism. That part of the front face of the breechblock which covers the bottom of the bore consists of a removable face plate of hard steel, dovetailed into the face of the block and secured by two screws. By the downward movement of the breechblock the breech is opened, the empty cartridge case is extracted, and the firing mechanism is cocked. The breechblock is moved, and also held fast when closed, by a crank arm, which has a small stud in its end, traveling in a groove in the block. The crank shaft is journaled in the right cheek of the breech, carrying the crank handles at its outer end and having a small spring catch to hold the breech closed. The hammer is mounted in the middle line of the breechblock, and it carries a detachable firing pin which passes through a hole in the face plate to strike the primer of the cartridge. A loose trigger is carried in a pistol grip secured to the rear of the breech; when the breechblock is closed, this trigger is brought in contact with the sear, so that by pulling it the hammer is allowed to fly forward and fire the gun. The extractor is a single piece of steel working in a longitudinal groove in the left cheek of the breech. Its forward end is shaped into a hook to grasp the head of the cartridge. On the same side of the extractor as the hook is a small stud, which travels in a curved groove in the breechblock, thus giving motion to the extractor. When the breechblock is run down it is prevented from dropping clear out of its mortise by a stout stop bolt

screwed through the left cheek of the breech, its end traveling in a groove in the left face of the breechblock.

50. Seabury 6-pounder rapid-fire gun.—The gun proper is very similar to other rapid-fire guns of the same caliber, the difference being confined to the breech mechanism. In this gun an interrupted-screw breechblock is used, and by the continuous movement of a lever hinged to the right side of the breech it is rotated, withdrawn until it rests upon a swinging carrier tray in rear, and then swung to one side, leaving the breech open for loading The rotation of the block is accomplished by means of a yoke projecting rearward from the block, and having a curved slot within which the lever moves backward and forward. As the lever begins to move it rotates the yoke and breechblock, and when the threads of the block are disengaged the lever brings up against the end of the slot and withdraws the block until it rests on the carrier tray and unlocks it from the breech. Then, continuing the motion of the lever, the block is swung around to the right. The opening of the breechblock operates the extractor to force out the cartridge shell, and cocks the firing pin. There is a safety device, so that the gun can not be fired before the block is completely locked. A reversal of the movement of the lever swings the carrier tray back, then pushes in the breechblock and turns it. The piece is fired by a trigger as in the other guns.

51. Driggs-Schroeder 6-pounder gun, on crinoline mount.—The gun is "built up," and it consists of a tube, jacket, and hoop. The breechblock engages in the jacket. The hoop, the first piece to be shrunk on the tube, is slipped on from the muzzle end until the shoulder on its interior is close against a corresponding shoulder on the tube. The jacket is then put on from the breech end. This method insures perfect contact at the shoulders between the tube and hoop. On the exterior of the gun is cut a screw thread, part of which is on the hoop and part on the jacket, and on this is screwed the trunnion band, thus locking the entire system and preventing any longitudinal motion between tube and jacket or hoop. The breechblock, which is a single piece, has first a motion downward, to disengage it from its support, and then a rotary motion to the rear. This support is effected by bands upon the top and sides of the block. The sides taper slightly toward the top, so that the bands, which engage in grooves in the interior of the breech, are released from these grooves by the downward motion of the block. These grooves are inclined about 2° 30′ to the front and upward, so that the block when pushed up into position in closing is also pressed forward, forcing the cartridge case home, and the block in opening readily detaches itself from the head of the case. There is a spring lock on the operating handle, and this lock, when the breech is closed, prevents the block from moving under stress of any kind except that applied directly to the handle. The

handle turns a shaft which forms the hinge of the breechblock, but this shaft is formed with a cam which forces up the breechblock in the final operation of closing, the hinge hole in the breechblock being elongated to allow this motion. In opening, the cam as it turns withdraws the axial firing pin and forces down the block, so engaging with the block that a further rotation of the cam carries the block with it. The extractors, one on each side, lie flat against the face of the tube of the gun and in recesses in the front face of the block. The bearing surfaces on the extractors are so arranged that the motion is at first slow, with a powerful leverage. During the latter part of the rotation of the block the motion is quick. The breechblock can be opened and closed with ease by the left hand, and it is claimed that the best service is obtained by having the operating handle on the left side.

The gun is mounted on a crinoline nonrecoil mount, which consists of two main parts—the pivot and the stand. The pivot is a single gunmetal casting, having the upper end forked like the letter Y and the lower end shaped to fit the socket in the stand. The upper part of the Y is fitted to the trunnions, which are secured in place by cap squares held down by screw bolts. In order to clamp the gun at any angle of elevation the bolt heads have holes to receive the end of a small lever, by means of which they are screwed down hard and the cap squares forced down so as to bind the trunnions. The stand is a single steel casting with eight legs and socket, all being in one piece. The shoulder rest is attached to the right side of the gun and the gun is fired by means of a trigger.

The total length of the gun is 107.3 inches and the length of the bore is 100.98 inches—that is, 45 calibers. The projectile weighs 6 pounds and the powder charge is 3½ ounces of cubical powder. The initial velocity is about 1,900 feet per second and the range for 13-degree elevation is about 5,500 yards.

VOLLEY GUNS AND MACHINE GUNS.

Even in the days of matchlocks examples are found in which several guns of small caliber were attached to the same stock and fired successively by the same man, and the accompanying print shows a revolving cannon of the sixteenth century. This had one barrel, through which shots were fired successively from ten chambers in a cylinder revolving in rear. In each chamber two charges were placed, one behind another. The front charge was first fired, and then the rear one, a slow match being used, applied to vents over the powder. The vents were provided with sliding covers. The first systematic employment of guns of this class in war, however, was that of the French mitrailleuse, now obsolete. It is illustrated in the exhibit by description and drawings. The machine gun possesses the advantage over volley guns of giving a constant succession of shots by automatic reloading, and some guns

combine the advantages of both systems. These guns are usually of comparatively small caliber, firing small-arm cartridges, and they are either mounted as wall pieces or placed on carriages like field guns. They are here classed, therefore, as intermediate between cannon and hand firearms.

A remarkable development recently made in machine guns consists in the utilization of the recoil of the barrel to operate mechanism for reloading. These guns were at first too startling in action to be fully acceptable. Devices for making the breechblock fire the piece automatically in closing appear in several of the modern magazine guns, and other examples of automatic arms are described among hand firearm—sthe Pitcher automatic and the Freddi automatic recoil guns. Recent improvements in positive feed, to replace the gravity feed for machine guns, seem to offer great promise.

52. French mitrailleuse, represented in the exhibit by description and drawings.—This gun had 25 barrels grouped in parallel rows of 5, all terminating at the rear in one slot in the breech casing for the reception of a movable breechblock, having short cartridge chambers corresponding to the different barrels. Several of these blocks could be loaded up in advance, and after the shots were discharged from one it would be removed and another substituted. Each barrel had a separate firing pin, and these pins were released in succession by mechanism operated by a crank.

53. Vandenburg volley gun, with carriage, obsolete.—Said to be of English manufacture, and to have been captured from the Confederates. It consists of 85 barrels, caliber 0.46 inch, grouped in a cylindrical casing of bronze. A breech piece, with corresponding muzzle-loading cartridge-chambers, copper lined, fits in rear, this piece being attached to a hinge and slide, and having an independent screw block at the outer end to screw into the casing from the rear. After firing, the block had to be unscrewed, pulled out, and swung down. The chambers were then separately reloaded, the breech closed, and all the charges fired at once by a percussion cap in rear. The copper lining of the chambers projects a little from the block to fit into the barrels and serve as gas check.

54. Requa battery gun, with carriage, caliber .53, obsolete.—For simultaneous discharge of 25 barrels. The barrels are placed side by side in the same plane, and loaded successively at the breech with paper ammunition. The breech action gives a very firm support against the shock of discharge. All the barrels are closed by a single sliding plate, which is supported by another plate hinged to its rear edge, the free edge resting against a shoulder on the frame of the gun when the breech plate is pushed forward. The hinged plate is operated by a lever working in a vertical plane parallel to the line of fire. The lever is hinged to the frame and to the rear end of the hinged plate, so that pulling

the lever backward raises the plate over the supporting shoulder, and pulls it to the rear. The breech plate and hinged plate constitute practically a broad breechblock and locking cam, like that used in the Springfield breech-loading rifle, except that the breech plate, instead of being hinged to the barrels at the front, like the breechblock of the Springfield, is made to slide backward and forward. The gun failed with paper cartridges for want of a proper gas check, but for metallic-case cartridges the breech system would answer for guns of the type of the Nordenfeldt. The barrels can be brought together at the muzzle, or spread apart, as desired, by a lever below. Used at the siege of Fort Wagner, S. C.

55. Guthrie and Lee machine gun, caliber .70, obsolete.—Two barrels are fixed to the frame. At right angles to their length travels a breechblock, to which a horizontal hand lever gives a lateral reciprocal motion. By this movement chambers in the block are brought first opposite the barrels, and then opposite loading troughs fixed at the side of the barrels and in front of the block. Cartridges are placed singly by hand in these troughs, and pistons force the cartridges automatically into the chamber. When the chambers come opposite the barrels, the charge is fired by a concealed lock. The loading troughs and pistons are interesting pieces of mechanism. No record of this gun is accessible.

56. Union repeating rifle or coffee-mill gun, with carriage, single barrel, caliber .58, obsolete.—Short, muzzle-loading barrels or chamber pieces, with an axial nipple at the rear, are used to hold the charges. A number of these are loaded and capped and fed by means of a hopper upon a fluted cylinder, which revolves and brings the charges in succession in rear of the long barrel, pausing long enough to allow the charge to be fired. A wedge-shaped block, moving vertically in rear, forces each small chamber piece in turn forward against the rear of the barrel to prevent escape of gas, and serves to support the recoil. But one lock is used, working through a slot in the block. After firing, the chamber pieces are carried round to an opening which allows them to fall out. They can be reloaded and used again indefinitely. A crank at the side operates the breech mechanism. This gun was used at the siege of Petersburg.

57. Lowell machine gun, caliber .45.—Cartridges are fed from above by means of a vertical feed guide, grooves in the guide catching the flange and leaving the rest of the cartridge free. They fall on a block revolving about an axis parallel to the barrel, and drop successively into grooves in the outer surface. Turning a crank revolves this block and brings one cartridge after another opposite the barrel, the block remaining stationary long enough for the sliding breech bolt to push the cartridge into the chamber and draw out the shell after firing. One lock only is needed, and only one bolt. A firing pin worked

by a spring is released when the gun is loaded. This is the first gun here described using metallic ammunition. The gun has not stood the tests of service. The action is jerky and irregular. Four parallel barrels are provided with this gun. They are arranged to be turned around an axle. When a barrel gets heated up by firing, a new barrel is moved up, and so on.

58. Gardner gun, improved, with carriage.—This gun has two barrels side by side, to be fired alternately. A bolt is placed in rear of each barrel, and these bolts are actuated by cams on a horizontal shaft perpendicular to them. This shaft is turned by a handle at the side, and the cams are so placed as to draw out one bolt while pushing in the other, releasing a firing pin on each bolt when the corresponding barrel is loaded. The feed case, similar to that on the Lowell, is double, containing a row of cartridges for each barrel, a swinging plate closing openings below alternately. The barrels are inclosed in a hollow sheath of bronze, intended for holding water to prevent heating the barrels too much in firing. The water is poured in at the top at one end and allowed to flow off through the bottom at the other end.

59. Gatling guns, 10 barrels, caliber .45.—Two of these guns are shown, one of model 1890, and the other of earlier model. They are both mounted on their carriages. The barrels are fixed on a revolving frame, parallel to the axle of the gun, and they are revolved by turning a crank, which can be placed at the side or rear of the breech casing at pleasure. The frame projects to the rear of the barrels in the form of a drum, longitudinal slots in the outer surface holding opposite each barrel a sliding breech bolt with a spring firing pin. A curved lip on the interior of the stationary breech casing which envelops the drum engages the bolts and wedges them forward and back as the barrels revolve. When a bolt is well drawn back, its firing pin catches in another lip, which holds it back as the bolt moves forward. This compresses the firing spring, and the revolution carries the pin to the end of the lip, where it is released when the bolt is pushed home, and so the cartridge is fired. Cartridges fall successively from the feed case into the slots of the drum in rear of the barrels, through a mouth in the casing near the top, over the position of a barrel when the corresponding bolt is drawn back. By the forward and back motion of the bolts, as the barrels revolve, first the cartridges are pushed into the barrels, and then the empty shells are drawn out, a spring hook, which projects beyond the front of each bolt at the side, acting as extractor. The operations of loading, firing, and extracting the shells are going on in different barrels at the same time while the barrels are revolving. The gun has a universal-pivot mounting, which allows it to be turned in any direction by the pointing lever. Clamps secure it in any position. Cartridges are supplied to the gun of earlier model by means of

the Bruce feed frame, or by the Accles feed drum, the gun being fitted to receive either form. The old straight feed cases are practically abandoned.

The Bruce feed: In this a vertical frame over the mouth in the casing holds a swing plate, on the front face of which are two channels with undercut sides to catch the flanges of the cartridges. This plate can be shifted so as to bring these channels altenately over the mouth and allow the columns of cartridges to fall down by gravity. The ordinary paper boxes in which the cartridges come from the arsenals, holding 20 cartridges in two rows, can be used in the Gardner gun for filling the feed channels. The cover off the box, the flanges of all the cartridges can be slid into the channels, and pulling the box forward leaves the cartridges behind.

The Accles feed drum: This holds the cartridges in spiral guides within, a series of radial arms revolving together and pushing the cartridges toward the orifice. Projections on the revolving frame of the gun engage the ends of the arms and turn them by a positive motion without the use of an actuating spring in the drum. The drums hold about 100 cartridges, and with this attachment shots can be fired at the rate of 1,200 per minute. The drums can be readily filled from the cartridge boxes by an arrangement similar to the Bruce feed. The attachment for the Accles drum is omitted in the gun of model 1890, as that feed has been given up for the army service.

Recent changes in the method of feeding cartridges to Gatling guns are claimed to give great advantages in rapidity and sureness of action, and to involve less additional weight in feed cases. It is proposed to change the position of the handle to a point in the axis of the trunnion, so as to produce less liability to deflection of aim in turning the handle. It is also proposed to apply an electric motor for operating this handle, with an attachment for cutting off the connection with the gun at any moment without stopping the motor. One form of feed case is here illustrated.

The new Gatling feed cases consist of tin or brass strips of any desired length. Two rows of V-shaped slots are cut each side of the center, lengthwise of the strips, and opposite to a small rectangular recess which is punched in the edge of the plate. The tongues of these slots are bent upward, forming circular prongs of a diameter slightly smaller than the cartridges. When the cartridges are thrust into the clasp of the prongs the rims settle into the recesses to prevent endwise movement. Instead of having the vertical feed slot for the gun in the top of the casing a horizontal slot is made, passing over the carrier cylinder of the gun just in rear of the barrel. Through this slot the feed strips are pushed in from the left side, cartridges downward. The cartridges are caught successively by the edges of the grooves in the carrier cylinder and pushed along until released

from the prongs on the strip by a finger which wedges in between the strip and the cartridges. The cartridges are fed into the barrels in the usual manner. This device has been adopted by the Gatling company.

Another device is the new Accles feed. The feed case of this system is also a strip of tin or brass, but instead of having fingers clasp the cartridges the strip is corrugated so that the cartridges lie in successive hollows in the tin. These tins are set in pasteboard boxes, which are placed vertically on the gun a little to one side of the carrier cylinder. The box once in position, the lowest cartridge is caught by a toothed wheel turning about a horizontal axis on the left side of the piece, and it draws the cartridge down, pulling with it the corrugated strip of tin. The tin passes on and drops out at the bottom while the cartridges are carried around by the toothed wheel until they are pushed into position to be caught in the slots of the carrier cylinder, and fed into the gun in the usual manner.

60. Hotchkiss machine gun, or revolving cannon, caliber 1.457 inches, with carriage.—There are 5 barrels grouped around a common axis revolving in front of a fixed breech cylinder. For smaller calibers 10 barrels are sometimes used. The barrels, of the finest oil-tempered cast steel, are held in two disks on a central shaft, the rear end of the shaft passing through the face of the breech cylinder to receive a rotary motion from the driving gear within. A rectangular frame, which is attached to the breech, passes forward around the front of the barrels to support the front end of the shaft. The breech cylinder is a single piece of cast iron weighing 385 pounds. This absorbs the greater part of the recoil. There is a cavity at the rear end closed by a door which can be easily opened, so that the mechanism in the cavity is accessible. The mechanism can, if necessary, be taken out and put in place in a few minutes without the aid of any special tools.

A peculiar feature in this gun consists in the intermittent revolution of the barrels, which remain stationary during the discharge, so that there is no movement of any kind to impede the accuracy of the fire. This stop, or lost motion, is obtained by the shape of the driving worm, which is so constructed that the inclined driving thread only covers half of the circumference of its shaft, the thread being straight on the other half. The effect of this is that the barrels revolve only during half a revolution of the worm and stand still during the other half revolution. The combination of the mechanism is so arranged that the loading, firing, and extracting take place during the pause. This feature is of great importance for the accuracy of the fire and the durability of the system. The worm shaft projects through the breech on the right side and it is turned by means of a hand crank. On the left side of the worm shaft a small crank is attached and this operates the mechanism for loading and for extract-

ing the cartridge shells. Two openings are made in the front face of the breech, one above for loading and another below for extraction. A loading bolt reciprocates in rear of the first in a trough within the cylinder, and an opening in the wall of the cylinder admits the cartridges. The cartridges, fed from a hopper through a feed opening in the wall of the breech cylinder, fall successively in front of the loading bolt, which, while a barrel is stationary in front of it, pushes a cartridge in. The revolution of the barrels brings them successively opposite a solid part of the breech which supports the base of the cartridge. During the pause of the barrel here the cartridge is exploded by a firing pin working through the breech. The shell is carried on down opposite an extractor which draws it out and lets it fall to the ground. The operations of loading, firing, and extracting are performed in different barrels at the same time, during the intermittent pauses, by a single set of parts answering for all the barrels in succession. The system is hardly rapid enough for the smaller calibers. The solid support of the cartridge at the moment of firing is a great advantage and the pause of the barrel at the same time insures greater accuracy. To obviate the difficulties of feeding, when the cartridges are piled one upon the other, the feed opening is closed by a hinged gate, which turns down by the weight of the cartridges, the first of which drops into the trough; then the piston moving forward raises the door and allows no more cartridges to enter until the proper time. Should rapid firing be required, the gun is supplied with feed cases, containing ten cartridges each. In this manner 60 to 80 rounds per minute can be fired with only three men to work the gun. The carriage is made of steel and all the fixed parts, except the fellies and spokes, are of metal. The gun is supported on the carriage by an iron turntable which has two forks projecting upward at the sides to hold the trunnions. The bottom of the turntable is pivoted to the top of the carriage, thus allowing the piece to be swung laterally.

The rifling is one turn in 4 feet; the weight of the shell with fuse is 16.05 ounces; charge of powder, 4.3 ounces; weight of piece, 1,047 pounds; weight of carriage complete, 1,092 pounds. The extreme range is about 5,140 yards.

61. The Nordenfeldt machine volley gun.—This is represented in the exhibit only by drawings and descriptions. From 2 to 7 barrels are arranged side by side on a frame, as in the Requa battery above described. These barrels are all loaded at once by means of breech plugs attached to a sliding plate in rear. This plate is moved forward and back by a lever working horizontally on the right-hand side. Each breech plug contains a firing pin, and behind the plug is a hammer operated by a spring. When the lever is drawn back and the breech plate is brought to the rear, the hammers engage in a sliding comb on the frame, and at the forward movement they are held back

and cocked. When the breech is closed, the lever still moving forward secures the breech piece by operating a swinging plate, which, by means of cam surfaces, pushes locking bolts on the breech plate into mortises in the side frame. Further motion of the lever slides the comb which holds the hammers, and releases them one after another. For each barrel a feed case is required, placed in rear and a little to the left. A slide plate carries the cartridges to the right, in front of the breech plugs when drawn back, and a forward motion of the plug pushes the cartridges into the barrels. All the barrels are loaded at the same time, but fired separately, though in rapid succession, the interval of fire from the different barrels depending on the rapidity of motion of the lever. The effect is, therefore, practically that of a volley; but the shock of recoil is not so great as if all the barrels were fired at once. Many of these guns are used in England, but none are used in this country. They are shown in the Maxim-Nordenfeldt exhibit.

62. *Maxim automatic recoil machine gun, caliber .45.*—This gun may properly be described as automatic, the recoil of the barrel at discharge being utilized to reload—that is, to open the breech—thus extracting the empty shell, withdrawing a cartridge from the cartridge belt, dropping the cartridge into position to load, and cocking the piece; then to close the breech, thus inserting the cartridge into the chamber, shifting the belt, and seizing a cartridge for use at the next round. Opening the breech, with its attendant operations, is performed directly by the recoil of the barrel, this at the same time stretching a heavy coiled spring. The spring, by its reaction, returns the barrel to its original position and closes the breech, thereby inserting the cartridge and grasping a new one. Screwed to the rear of the barrel is a frame extending to the rear, and reciprocating in a rectangular case which envelopes the breech mechanism. In this frame the breechblock, containing the firing pin and other parts of the lock, reciprocates by an independent motion. This frame consists of two vertical plates and a connecting end piece. By a very ingenious arrangement, a single spring serves to check the recoil and to operate the breech. This spring, instead of being fixed to the sliding frame itself, is fixed to the projecting end of a shaft, which passes horizontally through journals in the sides of the frame in rear of the breechblock. One end of the shaft has a cam on which a chain from the spring can wind, and the other end of the shaft has a vertical lever, which strikes a fixed arm on the case when the barrel recoils, and causes the shaft to turn. This shaft has a crank arm between the walls of the frame, and the breechblock is connected with the crank arm by a link. This breech link branches at the front and passes on both sides of the block nearly to the front, where it is pivoted, longitudinal slots in the case allowing the shaft to move back and forth

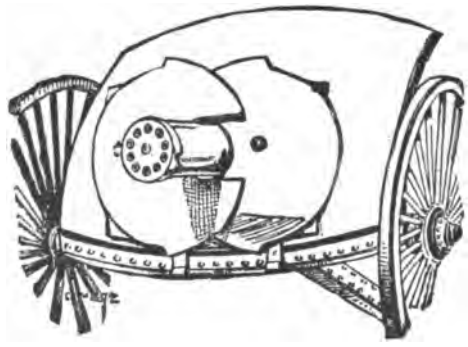
with the frame. When the frame moves back, the crank arm bends down, carrying with it the rear end of the link and drawing the breechblock back from the breech; the breech being closed when the crank arm and link are horizontal. The recoil spring is fastened in front to the outside of the case. The recoil of the barrel stretches the spring, and the turning of the crank stretches it still more, so that the reaction of the spring turns the crank and closes the breech, while at the same time pulling the barrel forward to firing position.

The gun is supplied with cartridges from a belt. The cartridges lie side by side across it, the belt being made of two pieces of tape riveted together with intervals for single cartridges. Each belt holds 334 cartridges. This belt passes from right to left through the feed slot on the top of the gun. In the feed slot is a slide moved to the right or left by a lever, as the barrel, moving backward or forward, strikes the other arm of the lever which is pivoted to the case. The slide carries two movable pawls which hook over one cartridge after another and draw the belt to the left, carrying the cartridges successively over the barrel, the flanged end of the cartridge projecting far enough to the rear of the barrel to be caught by an undercut or flanged plate which moves vertically on the face of the breechblock. This plate serves as an extractor. It is slid up and down by levers pivoted to the breechblock, and moved by arms projecting from the front branches of the breech link. The lips of the extractor groove fit over the flange of a cartridge in the belt and over the flange of the cartridge shell in the barrel, so that the block in retracting draws both back, pulling the cartridge from the belt and the shell from the barrel. Then the extractor plate drops, lowering the new cartridge to the level of the barrel and the empty shell to the ejector tube below. The forward motion of the block pushes the new cartridge into the barrel, and toward the end of the motion the extractor plate is moved up, sliding over the head of the cartridge in the barrel and engaging a new cartridge in the belt, while the empty shell is left free to drop out. The breech link, in swinging down and drawing the breechblock back, cocks the piece by striking a lever or tumbler, which throws back the firing pin, a safety catch at the top of the block engaging the firing pin, to prevent it from swinging forward until the breech is again closed. A sear engages the tumbler, and the sear is tripped by a trigger placed in rear of the casing and connected with the sear by a sliding plate. After the gun is once loaded and the belt put in place, continuous fire can be produced by pressing on the trigger until a belt is exhausted. The hands grasp handles in rear and the thumbs press the trigger forward.

There are 4 magazines or receptacles for ammunition, 2 being situated above the axle and 2 below. Each one of these contains 4 boxes, each box holding 250 to 300 rounds of ammunition placed in belts and ready for immediate use. The front walls of the magazines are formed

of thick steel plate, which forms a shield for the ammunition. There is also a light shield attached to the cross head for protection of the man aiming the gun. The elevation is given by an elevating screw and the traversing is effected by the gunner, who controls the gun by the handles in the rear. The gun is capable of firing 600 shots per minute. It is an American invention developed abroad. Loaned by the Maxim-Nordenfeldt Company.

63. Buffington steel carriage for machine guns.—The carriage is formed of steel plates, so arranged that the body forms a hollow axle between the wheels. This gives room for storing a large supply of cartridges, instead of depending wholly on the supply in the limber chests. A curved shield, extending upward from the front of the carriage, has been devised to give greater protection to the gunners, but the especial feature is the arrangement by which the gun can be aimed as desired, though the shield is fixed to the carriage, without exposing the gunners through a wide opening for the muzzle. A square opening in the shield is covered in front by a curved slide, free to move laterally, and in this slide an opening the width of the muzzle extends from top to bottom. This opening in the slide is covered by two overlapping disks, pivoted centrally to the slide, on either side of the opening, these disks having notches cut out where they overlap, the notches allowing room for the muzzle to protrude. Just enough play is given to allow sighting through the opening. The slide allows lateral movement of the muzzle, and the disks allow a vertical movement in any position of the slide. It is intended to have a steel flap hinged to the under part of the carriage filling the opening below, and to sheathe the wheels if necessary. Though a Gatling gun is now mounted on this carriage, it is intended for any gun that needs to be pivoted on the carriage. The limber constructed to use with the Buffington carriage and Williston harness has a wooden chest fastened permanently to the frame and axle of steel. The lid of the chest, hinged in front, is made of steel, and it is intended, when raised, to serve as a shield to protect men at the chest. In front of the chest is a shelf with a low iron railing. A doubletree is used with singletrees attached. The pole has no permanent yoke and no straps, but a projection a little in rear of the pole pad prevents the ring of the neck yoke from slipping back.



Buffington steel carriage for machine guns

HAND FIREARMS.

A very full collection of these arms is shown, indicating the development from the earliest times, and including many of the most recent magazine guns of to-day. Most of the guns are from the fine collection at the national armory, but many were loaned for exhibit. The descriptions of hand firearms are divided into the following classes: Matchlocks, muzzle-loaders; wheel locks, muzzle-loaders; flintlocks, muzzle-loaders; percussion locks, muzzle-loaders; single breechloaders; repeating arms, including revolvers and magazine guns. Though the breechloaders and revolvers involve the use of the different kinds of locks described in the first four classes, the locks are not the distinctive feature. No separate classification of smoothbores and rifles is made. Rifling with straight grooves was used as early as 1498, with round balls, but the advantage of spiral grooves, introduced in 1520, appears to have been an accidental discovery. The rifle was first used merely as a sporting arm, and it did not come into military use until the middle of the seventeenth century. Its use was not common until toward the end of the eighteenth century, and then only for cavalry.

As early as 1742 Robins pointed out the advantage of using the oval or elongated form, but no efficient way of using such bullets in muzzle-loaders without deforming them was devised until 1836,[a] when William Greener, in England, invented the expanding system by which the action of the powder spread the base of the bullet into the grooves. He used a conical pewter wedge partially inserted in a cavity in the base. Minié afterwards used the same principle, and later still the base wedge or cup was abandoned, the base cavity alone serving the purpose. Bullets for breech-loading rifles do not require this cavity in the base, as they are made a little large and are forced into the grooves. Delvigne in 1827 improved the accuracy of rifle fire with round balls by attaching a sabot, which rested on the shoulders of the cylindrical powder chamber in the bottom of the bore, so that blows from the ramrod spread the bullet into the grooves. This method was afterwards applied by Delvigne and Minié to elongated bullets composed of a cylinder with a conoidal point, the sabot being omitted; and the same principle was used in Thouvenin's *carabine à tige*, in which Delvigne's form was replaced by an iron spindle screwed into the bottom of the chamber. It is remarkable that the modern breechloader should have appeared about the same time that percussion muzzle-loaders were generally introduced, and about the time that elongated bullets began to be used in rifles.

[a] It is said that as early as 1817 it was proposed in Russia to use an elliptical ball having a cavity in rear, for rifles. This is the first suggested use of the expansion system, but it appears to have been lost sight of.

The Americans made excellent use of rifles during the Revolution, and the effect of the Kentucky rifles at the battle of New Orleans in 1815 seems to have drawn especial attention to the advantage of using them, even with round balls. In this country military rifles were made as early as 1814, at Harpers Ferry, but the mass of American infantry were armed with smoothbores until 1855. It is interesting to note the progressive reduction in caliber of military rifles, making the size of the bullet a very fair guide to the period of manufacture.

MATCHLOCK GUNS.

Hand guns first appeared in the fourteenth century—the earliest ones requiring to be touched off, like cannon, by means of a slow match held in the hand. These were called hand cannon, petronels, culverins, etc. (the recoil of the petronel being taken up on the breastplate instead of on the shoulder). The matchlock soon appeared. It had a swinging cock on the gun to hold the slow match. It was fired by forcing the cock down, and so bringing the slow match to the firing pan. In later models the cock had a lever attached to act as trigger for bringing the slow match down. The matchlocks are the earliest models shown in the exhibit. Many of these early guns were so heavy that a crutch had to be used to support them in firing.

64. Matchlock musket, Formosan.—Captured from the Boutans and Kussikuts, of Aboriginal Formosa, at the Battle of Seik Mon (Stone Doors) by the Japanese troops under General Saigo, May 22, 1874. This represents the earliest form of matchlock referred to above. It has no trigger. It is of form and weight to be fired from the shoulder.

65. Matchlock musket from India, date unknown.—British coins on butt. The bands and mountings are silver. This has a trigger for operating the cock. The butt is bent downward and then upward, forming a curious curve. The construction of the gun and its general finish are of the most primitive character.

66. Matchlock musket, caliber .717, of fourteenth century.—The trigger works an intermediate lever to bring the lighted end of the match into contact with the pan. One objection to the matchlocks was that the blast from the vent or touchhole would blow out the match. This gun is light enough to fire from the shoulder.

67. Matchlock musket, caliber .56, history unknown, probably eastern.—Has a trigger for operating the cock, but the trigger is pushed up instead of backward as in other guns. The stock is nearly straight. The barrel was originally covered with gold leaf, and the stock was ornamented with same. No trigger guard is found on the matchlock guns.

68. Matchlock musket, Chinese, loaned by Mr. E. Thomas, gunsmith, Chicago, Ill.

69. Old matchlock gun from India, barrel 14.5 feet long, caliber 1⅛ inches, loaned by S. J. Telléry & Co., East India pavilion.—Mounted on a wooden stock with shoulder piece, with attachment for supporting on a wall in firing. Shown in shooting gallery.

WHEEL-LOCK GUNS.

These guns first appeared early in the sixteenth century. They originated in Germany. The lock is very ingenious and complicated. In these locks a piece of flint is pressed down by a spring against a revolving wheel of tempered steel placed under the pan. The friction between the surfaces produces the sparks that ignite the powder. The flint is held in a clamp hinged in front. A ribbon spring round the arbor of the wheel is wound up by a key, and pressing a trigger releases the wheel and allows it to revolve. Two of these guns are shown. These locks were used principally for sporting purposes, and as a military arm they were used for the most part by mounted troops, the matchlock for infantry not being supplanted until the adoption of the flintlock. All the early arms were so slow to load that in a battle as late as 1636 they could be fired only about once an hour.

70. Chinese wheel-lock pistol, caliber .492.—This shows very fine work. The stock is inlaid with ivory.

71. Wheel-lock gun, caliber .707, date about 1520.—Used in the field with a crutch to support the barrel. Stock highly ornamented. The barrel is marked Gottfried Fleming. Engraving of battle scene on lock plate. This gun was probably used as a wall piece or with a portable crutch in field firing. A slide covers the pan to keep the priming from falling out. The key is separate. Winding up the spring slides the pan forward. The lock has a set trigger. It is remarkable for the fineness and force of its engraving and for the general beauty of its form and finish. A detached wheel lock is also shown in working order. By pressing a knob outside the lock plate, the pan cover slides back and protects the priming from wet or loss. The key is permanently attached to the arbor winding up the spring.

FLINTLOCK GUNS, MUZZLE-LOADERS.

The flintlock mechanism appeared in a crude form in the snaphaunce, invented late in the sixteenth century, in Holland, pyrites being used in the hammer instead of the flint, which did not appear until about 1630. The improved flintlock was introduced into the French army in 1680, and it continued to be used in all armies until about 1842, when the percussion lock replaced it. The period covered by the use of the flintlock saw three particularly important advances in the efficiency of hand firearms: (1) The introduction by Gustavus Adolphus in 1630 of the cartridge box, and the use of the paper cartridge, having the ball and its proper charge wrapped together, in place of

having the powder and balls carried separately, as before. Before this period the powder charges were carried in wooden boxes hung from the girdle, and in still earlier times the powder had to be measured out for each fire. Some authorities give an earlier date, 1569, for the use of the cartridge in Spain; (2) the substitution of the bayonet for the pike, 1682–1691; (3) the introduction of the iron ramrod, 1698–1741.

72. Arab musket, caliber .727.—Barrel, 4 feet 10 inches long; total length, 6 feet 1 inch long; highly ornamented barrel and stock. The cocking of the hammer draws the pan cover over the pan and protects the priming from wet, etc. The fall of the hammer pushes this cover forward and allows the sparks from the steel to fall into the priming and ignite the charge. Six bands of sheet brass hold the barrel to the stock. The butt plate is of bone, and is highly decorated on the sole. The length of guns of this class is probably due to the imperfect gunpowder manufacture of the period. This being used with a slow-burning mealed powder, the long barrel was necessary to allow complete combustion.

73. Albanian musket, caliber .72.—Silver mounted. Resembles very much, in length, style of ornamentation, etc., the Arab musket, but it is banded and inlaid with silver. The hammer has a special dog outside the lock plate for holding it off the steel. The hand of the firer is protected from abrasion by a leather flap. The piece has no trigger guard. The butt is of brass and uncomfortably narrow.

74. Old flintlock, unknown.—"Truitt Bros. & Co." marked on lock plate. No bands and no date given. The barrel is octagonal and the bore septagonal.

75. Flintlock musketoon, caliber .75, enlarged at the muzzle to 1.05.—Used by cavalry or dragoons; provided with swivel bar and ring; marked U. S. on barrel; brass mountings; barrel keyed to stock.

76. English "Brown Bess," .75 caliber, flintlock, bayonet, 1690 to 1840.—Loaned by Colt's Patent Fire Arms Manufacturing Company; bears on lock plate "Tower," and "G. R." under crown; barrel keyed to stock, brass mountings. This is the arm with which almost all the fighting of the Revolution was done.

77. English smooth-bore muzzle-loading flintlock musket, caliber .75, model 1747.—Marked "King's Own Regiment" on barrel; Revolutionary trophy; no bands around the barrel; on lock plate, "Iordan 1747" and "U. S.," also "G. R." under crown.

78. Flintlock musket, French, caliber .72, model 1763.—Marked U. S. on barrel and lock plate; barrel fastened with three iron bands to stock; mountings of iron; swivel loops for gun sling, with bend for lug. "M 1763" on tang; on lower part of lock plate "U. S." and "H. R." under crown, and also "Manf. Royale de St. Etienne." This is apparently the arm which served as a model for the first muskets

made for the United States. These were made at the private factory of Eli Whitney in 1798 or 1799.

79. Flintlock musket, "Queen's Arm," used by minute men of the Revolution, 1776, caliber .81.—Brass butt plate and guard, no bands.

80. Old flintlock, loaned by Mr. E. Thomas, Chicago, Ill.—Two brass bands and one iron band joining barrel to stock. No marks on gun, and date unknown.

81. Old Springfield muzzle-loading flintlock musket.—Marked on barrel $\frac{\text{U S}}{\text{N C}}$. Making parts of United States guns by machinery was successfully accomplished in United States arsenals between 1813 and 1825, all parts being made interchangeable except breech screws, which were not made by machinery until 1853. This interchangeability of parts was first accomplished by Hall in the construction of his breech-loading rifle at Harpers Ferry, begun in 1813.

82. Old Springfield muzzle-loading flintlock musket.—Marked on barrel $\frac{\text{U S}}{\text{V}}$.

83. Springfield smooth-bore flintlock musket, caliber .70, model 1818, magazine primer.—An arm projecting forward horizontally from the eye of the hammer gives a partial revolution at each movement to a fluted cylinder forming the bottom of the pan. As the hammer is drawn back to cock it this cylinder revolves to the front and takes its charge of priming powder from the brass magazine above it. As the hammer falls the cylinder is brought back opposite to the vent in time to receive the sparks from the steel. Bayonet without clasp. This illustrates the attempts made long before the invention of percussion priming to prime the flintlock automatically. These magazines for automatic priming were the precursors of the magazine for percussion priming used with the first percussion lock, described further on in connection with the Forsyth pistol, invented in 1807.

84. Five blunderbusses, iron and brass barrels, wall pieces, 1776 to 1820.—Two of these are bell-mouthed and three cylindrical; four have swivels for use as wall pieces.

PERCUSSION LOCK GUNS; MUZZLE-LOADERS.

Even with the early flintlock guns attempts were made to provide a method of automatically depositing priming powder in the firing pan, and a magazine for this is shown among the United States arms (No. 12, flintlock guns). Apparently several special priming powders also were devised, some partaking of the nature of fulminating powder, proposed not only for priming but for charging the gun itself; but the credit of applying percussion to their explosion in the firing pan without striking fire as in the flintlock is awarded to Alexander Forsyth, who, in 1807, invented the punch lock described below, using a powder

priming composed principally of chlorate of potash, and depositing it from a magazine. The percussion cap proper did not appear until 1817, when it was invented by Shaw, of Bordentown, N. J.,[a] though its invention has been ascribed to Thomas Egg, an English gunsmith, in the year 1818. The percussion cap, however, did not come into general military use until about 1840, when most countries adopted the percussion system. Meanwhile, about 1830, the punch lock was improved by Dr. Samuel Guthrie, of Watertown, N. Y., who used pellets of fulminating powder in place of fine priming powder, and his gun was used extensively by sportsmen. His gun is shown in the exhibit, and described below. Fulminate of mercury was not proposed for percussion arms until 1819, though known from 1764. The Maynard primer was adopted in the United States in 1854, but abandoned in 1860. It was a waterproof tape holding at regular intervals pockets of percussion power, the operation of the lock bringing them successively over the firing nipple. Specimens of these locks are shown; also an apparently earlier form of foreign design of 1839, with a hammer underneath. Later, the metal-covered percussion pellets or disks for the Sharps breech-loading rifle are to be noted.

85. Forsyth's punch-lock pistol, caliber .56, with magazine for percussion powder, 1807.—The earliest percussion lock known. This is a muzzle-loading pistol. Extending forward from the hammer is a bar connecting it with a sliding magazine, which contains the percussion priming powder. Cocking the hammer draws back the magazine, so that a few grains may drop from an aperture in the bottom into a cavity in the pan below. When the trigger is pulled, the magazine is pushed forward as the hammer falls, so that the punch on the end of the hammer falls into the pan without striking the magazine, and explodes the priming, the fire being communicated to the charge through a vent in the bottom of the cavity.

86. Guthrie's pellet-primer rifle, 1830.—Loaned by Jefferson County Historical Society, Watertown, N. Y., through the courtesy of Col. W. B. Camp, president, and D. S. Marvin, librarian. Octagonal barrel and septagonal bore. This interesting arm was invented by an American, Samuel Guthrie, M. D., the discoverer of chloroform. It is a punch-lock gun like Forsyth's, just described, but instead of the percussion priming powder used in Forsyth's gun, a pellet of fulminating powder was used, dropped into a small cavity corresponding to the pan of the old flintlock. The end of the hammer was sharpened, so that the point would fall into the cavity and explode the pellet. At the United States military post, Sacketts Harbor, N. Y., in 1826–1828, Dr. Guthrie is known to have fired the evening gun by percussion instead of using the old slow match, which preceded the friction primer

[a] Shaw was an Englishman who came to America to introduce his invention. He is said to have received $18,000 from the United States Government.

for cannon. He soon after altered the sporting flintlock gun to a punch lock, and the latter came into very general use, about 1830, in New York and in neighboring parts of Canada, the percussion cap not being generally known. From the shape in which the fulminate was used, the gun was also known as the pill gun. In the sample exhibited the old flintlock hammer appears, but instead of the flint a pointed steel block is held in the jaws to form the "punch." This device of Guthrie's made the alteration of flintlock guns by sportsmen comparatively easy. Some of the original pellets were also exhibited, and one of them was fired in the piece during the exhibition. The Smith punch-lock magazine rifle, described below, used similar pellets dropped one by one into the priming hole from a special magazine along the barrel. Though the Forsyth system dates back to 1807, no record of its extended use in this country has been found until Dr. Guthrie's changes were made.

87. Austrian smooth-bore punch-lock musket, caliber .705.—This is evidently a detonating gun, operated by exploding a percussion capsule in the pan. The pan is covered by a lid, on the principle of the flintlock, and a pin works through this lid, acting on the capsule below. The hammer strikes the pin and explodes the charge. This detached firing pin is the precursor of the firing pin seen later in many breechloaders.

88. English muzzle-loading musket, caliber .70, hammer underneath for ribbon primer, 1839.—Hewitelup's patent. The barrel is attached to the stock by three iron bands. This appears to be a forerunner of the Maynard tape primer, tried in our service before the rebellion. This gun is also adapted to use with the percussion cap, and it is the earliest specimen of that kind shown in the exhibit. Loaned by Colt's Patent Fire Arms Manufacturing Company.

89. Springfield smooth-bore musket, caliber .69, model 1842.—The first model of the United States percussion musket, used in the service in the Mexican war. The supply being insufficient, however, flint locks were generally employed. Bayonet has clasp.

90. Springfield smooth-bore musket, caliber .69.—Altered from the old model flintlock to percussion in 1852. The bayonet has a clasp. Many of the altered locks were used in the first years of the rebellion, as new arms could not be supplied in sufficient quantities. Though new percussion locks were made in 1842, no record of alterations of old flintlocks at Springfield appears until 1852.

91. Harpers Ferry sharpshooter's rifle, caliber .75, 1847.—Used on tripod; peep sight on trigger; globe sight on barrel.

92. Short rifle, Harpers Ferry, caliber .535.—Manufactured 1848; browned barrel; brass mountings; patch box in stock.

93. Springfield smooth-bore musketoon, caliber .69, 1851.—Brass butt plate; guard and bands; ramrod in swivel to prevent its loss on horseback; long swivel bar.

94. Pistol carbine, smooth bore, caliber .547, 1851.—The gun has a detachable stock, brass butt plate, guard and band, and a swivel ramrod.

95. Harpers Ferry rifle, caliber .50, model 1855.—Browned. The gun was made for Secretary of War John B. Floyd, and used exclusively by him in target practice. The wood of the stock is remarkably fine. It has three bands.

96. Springfield rifle musket, caliber .58, 1859.—This gun has two leaf sights, 300 to 700 yards, percussion cap and Maynard primer. The Maynard primer was a waterproof tape or ribbon enveloping patches of fulminate placed at intervals throughout its length. The tape was coiled and placed in a round cavity in the lock plate, a hinged gate covering it. An arm from the hammer pushed the tape along step by step, causing a patch of fulminate to project over the nipple. The end of the hammer had a sharp edge which came down close to the mouth of the primer cavity and cut off the tape beyond. This primer was adopted in the United States in 1854, but abandoned in 1860.

97. Short rifle, Harpers Ferry, caliber .58.—Manufactured in 1859; browned barrel; Maynard primer and saber bayonet; patch box in stock.

98. Double-barreled rifle, caliber .51, Munich.—Lock-plate guard and butt plate engraved; no bands; ramrod on left side of stock; barrels superposed.

99. Short, heavy sporting rifle.—Private manufacture; made from stray parts.

100. Springfield rifle musket, caliber .58, model 1861.—This is the arm made in greatest numbers during the war of the rebellion. It differs mainly from the model of 1855 in the change in the rear sight and the omission of the Maynard primer. The necessity for the immediate production of guns did not allow time for the changing of the lock-plate tools, so as to reduce the thickness of the lock plate from the thickness required by the Maynard primer. Some of the minor details of the mountings are also altered.

101. English Enfield rifle musket, with saber bayonet, caliber .587, model 1861.—Has nipple protector held by chain on trigger guard. Many of these guns were imported and used during the rebellion. On the lower part of the lock plate is a crown and in the upper part "1861 Tower," and on the lower part of the barrel, near the tang, "TC. *25*25*." It has a brass trigger guard and brass butt plate. The Enfield rifles at this time were not made with parts interchangeable as in the United States rifles, and even the bayonets were fitted to special arms, so that they could not be interchanged.

102. "Garibaldi" rifled musket, caliber .72, with long sword bayonet.—The gun has brass butt plate and guard, but no bands. On barrel,

"Ferd Fruwirth" and "I. W." Has a leaf sight sliding in seat on barrel.

103. United States Springfield musket rifle and cadet rifle, 1864.—Percussion lock.

104. Muzzle-loading rifle, Russian Cossack cavalry, caliber .625, 1867.—Loaned by Colt's Patent Fire Arms Company. Has three bands of iron and a brass butt plate with double eagle on the upper part. Trigger is a round button beneath the stock, and the hammer has a circular finger hole. It has a double leaf sight, with no correction for wind. "E. Taunerson" on lock plate, a double eagle and "A. F." on barrel, near tang.

105. Board of pistols.—A few more pistols are shown on "board of pistols and revolvers," No. 238 of catalogue, as follows:

1. Ellis breech-loading pocket pistol, patented 1859.
2. Pocket pistol, smoothbore flintlock, cannon-shaped muzzle, caliber .45.
3. Pocket pistol, rifled, caliber about .25.
4. Pistol for firing signal lights, model 1861; signal light held in place by spring under barrel; fired by percussion caps.
5. Revolving pistol, "pepper-box;" percussion; self-cocking.
6. Remington, breech-loading, rifled, caliber .50, metallic cartridge.
7. Derringer (United States Navy), caliber .54, smoothbore, 1847.
8. Army, smoothbore flintlock, 1836, caliber .535; made by R. Johnson, Middletown, Conn.
9. Army, smoothbore flintlock, 1841, caliber .545; made by R. Johnson, Middletown, Conn.
10. Army, smoothbore, percussion, 1844, caliber .547; altered from flintlock; made by R. Johnson, Middletown, Conn.
11. Army, smoothbore, percussion, caliber .525; made by A. H. Waters & Co., Millbury, Mass.
12. French, smoothbore flintlock, 1830, caliber .66; made at Mutzig.
13. French, smoothbore, percussion, 1848, caliber .66.
14. "Springfield," smoothbore, percussion, 1842, United States model, No. 4, caliber .545.
15. Army, smoothbore, percussion, 1851, caliber .55, model 1842; made by H. Aston & Co., Middletown, Conn.
16. Prussian, smoothbore, percussion, 1867, caliber .66; presented to the United States by the Prussian Government.
17. Dueling (English), smoothbore, percussion, caliber .53.
18. Springfield (rifled, model 1855), caliber .58, Maynard primer, fitted for detachable stock.
19. Springfield, breech-loading, rifled, model 1868, caliber .50, experimental.

106. Board of gun locks.—The following locks are exhibited detached from the guns, and they show the evolution from the days of the flintlock to the present time:

1. Flintlock, "B. T." on inside of plate; Revolutionary.
2. United States, flintlock, Springfield, 1814.
3. United States, flintlock, Springfield, 1836; altered for peculiar mainspring and sear.
4. United States, percussion lock, Pittsburgh; original model of the Maynard primer lock, invented by Dr. Maynard, in 1853. From this the musket lock, model 1855, was perfected at the Springfield Armory.

5. United States, percussion lock, Springfield, 1831; altered for Maynard primer.
6. Unfinished model of Maynard primer lock.
7. United States, percussion lock (cadet), Springfield, 1854.
8. United States, percussion lock, Springfield, model 1842.
9. United States, percussion lock (cadet), Springfield, 1856, model 1855, Maynard primer.
10. United States, percussion lock, Springfield, 1860, model 1855, Maynard primer.
11. United States, percussion lock, Springfield, 1860, model 1855, nickel plated.
12. United States, percussion lock, Springfield, 1861.
13. United States, percussion lock, Springfield, 1861, browned.
14. United States, percussion lock, Springfield, 1864.
15. United States, percussion lock, Springfield, 1862.
16. United States, lock, Springfield, for breechloader.
17. United States, lock, Springfield, model 1866. This lock was taken from an unserviceable breech-loading rifle, model 1866, sent to the armory for repairs in January, 1871. The ingenious device of a tapering screw in the lock plate to regulate the dip of the sear nose was made by the soldier.
18. United States, lock, Springfield, model 1866.
19. United States, lock, Springfield, 1870.
20. United States, lock, Springfield, nickel-plated, model 1868.
21. United States, lock, Springfield, model 1873.
22. United States, lock, Springfield, model 1884. Safety notch in tumbler.
23. Confederate States, percussion lock, Richmond, Va., 1862.
24. Sharps's percussion lock for paper cartridge. C. Sharps's patent, October 5, 1852. Lawrence primer, R. S. Lawrence's patent, April 12, 1859.
25. Sharps's lock, for metallic cartridge.
26. Joslyn lock, for metallic cartridge. Joslyn Fire Arms Company, Stonington, Conn.
27. Joslyn lock, for metallic cartridge. Face of hammer differs from No. 27. Joslyn Fire Arms Company, Stonington, Conn.
28. English, percussion lock, Tower, 1861.
29. Spencer lock, for metallic cartridge.
30. Starr lock, for metallic cartridge. Starr Arms Company, Yonkers, N. Y.
31. Unknown model, trunnions on sear. Probably foreign.
32. Left-hand percussion lock, "J. Bishop" on plate.
33. Confederate States, percussion lock, 1863, Cook & Bro., Athens, Ga. No. 3086.
34. Confederate States, percussion lock, Fayetteville, 1864.
35. United States, percussion lock. Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn.
36. Confederate States, percussion lock.
37. Prussian, percussion lock, made at Potsdam.
38. United States, percussion lock; two hammers for single barrel. Lindsay's patent.
39. Ancient flintlock of supposed Spanish origin. Eighteenth century. Presented to the National Armory Museum by Mr. Samuel Powell, of Newport, R. I., through Capt. Howard Stockton, November 15, 1871.
40. Albanian flintlock.

BREECH-LOADING GUNS.

Breechloaders date back to the time of King Henry VIII. The earliest forms of French and German make, in the latter part of the sixteenth century, had a chambered breech piece similar in action to that described for the early Chinese cannon. These were matchlock guns. Some flintlock breechloaders, in latter part of the seventeenth century,

used a similar block, but had a barrel turning on a hinge below, as in the modern Smith & Wesson revolver, or made to swing sideways to allow inserting the chamber piece. These removable chamber pieces were really the first metallic-case cartridges. During the Revolution a breechloader was used to some extent by the English. It was closed by a screw turned in from below across the rear of the barrel. This was the Ferguson rifle. The first American breech-loading gun was the Hall, and this was the first breechloader adopted and put extensively into the hands of troops by any nation. Specimens of this gun and of the Ferguson are shown in the exhibit. The Hall gun was issued to United States troops in 1818, and used in the Black Hawk, Seminole, and Mexican wars, and even in the war of the rebellion, while the needle gun, generally supposed to have been the first, was not adopted by Prussia until 1847, and not used in war until 1866.

One very marked superiority of breechloaders over muzzle-loaders—besides the great advantage that rapidity of loading gives more time to aim, and if necessary greater rapidity of fire—lies in the impossibility of getting more than one charge at a time into the gun. The following statement of the master armorer at the Washington Arsenal will illustrate this danger with muzzle-loaders:

> The number of arms received here from Gettysburg was 27,574. The number found to be loaded was 24,000. Of these, 6,000 had 1 load each, 12,000 2 loads each, and 6,000 from 3 to 10 loads each. In many of these guns from 2 to 6 balls have been found, with only 1 charge of powder. In some the ball has been found at the bottom of the bore, with the charge of powder on top of the ball. In some, as many as 6 paper-case cartridges have been found, these cartridges (regulation ball, caliber .58-inch) having been put into the gun without being torn or broken. In one Springfield rifled musket there were 23 loads, each load in regular order. Twenty-two balls and 62 buckshot, with a corresponding quantity of powder, all mixed up together, was found in one percussion, smooth-bore musket.

In the following list guns marked with a star (*) were bought by the United States Government during the war of the rebellion.

Guns using paper cartridges.

In these guns paper cartridges were used—bullet and powder wrapped in paper which had to be removed, or, in the later models, cartridges in which the powder only was covered with paper, cloth, or other combustible substance, so that the powder and ball could be inserted together. They were usually fired with a separate percussion cap exploded by an exterior hammer, but the "needle guns" had self-primed cartridges. Many of these guns were modified to use metallic cartridges.

107. Ferguson breech-loading flintlock rifle, 1776.—Used during the Revolution. Loaned by Gen. J. Watts de Peyster, New York. Has "D Egg London" on barrel and "D Egg" on lockplate. Has leaf sight and no bands. The gun is loaded at the breech by means of a

screw plug that descends in one turn as low as the bottom of the bore to admit the ball and then the powder. The gun fires a round ball. It has a brass plate on side of stock on which the following is engraved: "Ferguson breech-loading Rifle. Patented March 7, 1777, in England. First used by the troops in line of battle at the Brandywine in 1777. Presented to Frederic de Peyster, Capt. Royal N. Y. Vols. by Col. (Local Brig. Genl.) Patrick Ferguson, B. A., 1779. Only perfect specimen in existence. Property of Brev. Maj. Gen. J. Watts de Peyster, S. N. Y."

Breech mechanism somewhat like this is figured and described by German authorities as made by Marshal Saxe in 1731. The authors state: "It is noteworthy that this carbine also had a large chamber for the reception of ammunition." They cite the following authority: "Barado y Génova, Armas portátiles de fuego, el moderno armamento de la infanteria y su influencia en el combate." (See "Die Kriegswaffen," by Emil Capitaine and Ph. von Hertling.)

Ferguson does not claim to have originated the screw, but to have made certain improvements rendering it practical, making that part of the screw plug which forms the breech of the barrel smooth and hollow, providing recesses and chambers for the escape of gas, making the screw thread more oblique, so that one turn would open the breech, etc.

108. Hall's breech-loading flintlock rifle musket, caliber .512.—Ten thousand of these guns were issued to United States troops in 1818. A muzzle-loading chamber piece hinged at rear in line of barrel could be tilted up to allow the insertion of the paper cartridge. A catch underneath holds the breech piece down when closed. No provision for a gas check was made in these guns, a joint loose for one thickness of writing paper, but binding on two, being considered tight enough to prevent the escape of gas, and yet loose enough for free manipulation. This is the earliest breechloader known to have been adopted and used extensively by any army, though the German needle gun, adopted in 1847, is generally supposed to be the first. Hall's gun was patented in 1811. It was the first gun made successfully on the principle of interchangeability of parts.

109. Same system, flint lock, model of 1832, caliber .535.

*110. *Hall's carbine, same system, percussion lock, caliber .642, with ramrod bayonet.*—This seems to be a flintlock of 1832, altered to percussion at later date. This gun resembles in all particulars the Hall's rifle before described, except as to the bayonet, which consists merely of the blade sliding under the barrel and capable of being withdrawn and fixed by the same means which held it sheathed. Similar to Greener's pencil-case bayonet, etc. A compound implement, screwdriver, etc., is carried in a cavity in the back of the butt, closed by an extension of the guard strap hinged at its forward end and held closed

or open by a spring. This is a very interesting arm. Three thousand five hundred and twenty of these arms were purchased for use in the Army during the civil war.

111. Hall's rifle, percussion, caliber .54.

112. Jenks's breech-loading navy carbine, caliber .52, 1843.—Paper cartridge, hammer on side of the barrel. Opened by drawing back top lever. By means of a link this draws back a sliding breech plug and exposes a round hole in the top of the barrel a little larger than the ball. The ball is inserted through this, and allowed to run forward to its seat. The powder is then poured in and pressed forward by reversing the movement of the lever.

*113. *Sharps's carbine, caliber .52, paper cartridge.*—Closed by a block sliding vertically across rear of barrel, operated by a lever below. Percussion cap and nipple. Edge of block sharp to cut off rear of paper cartridge. Gas check formed by undercut hollow in face of block. Sharps's guns were used in the United States Army as early as 1846, in the Mexican war, and during the rebellion. In Sharps's carbine the primer consists of small pellets of fulminate, inclosed in a copper casing so as to be waterproof. In shape they resemble a 5-cent piece, but are only about three-sixteenths of an inch in diameter, and of proportionate thickness. Two dozen or more of these are placed in a hole, bored vertically in the lock plate, and are forced up by a spiral spring until the upper one arrives at a horizontal groove which extends forward and opens just in the rear of the nipple. As the hammer descends, it moves forward a small plunger that slides in the groove, the front end of which forces forward the topmost pellet out of the groove into the air, when it is caught by the cup-shaped face of the hammer, which carries it down upon the top of the nipple and explodes it. Of course, the gun can be fired by the ordinary cap, without the primer, if desired, and a device is attached by which the primer may be made to operate or not, at will. Cartridges for this and similar guns were constructed of linen cloth, the rear end being covered with tissue, or bank-note paper, through which the fulminate will ignite the powder, thereby saving the necessity of tearing the cartridge.

114. Sharps's rifle, caliber .58, paper cartridge, Maynard primer.—In this model the breechblock is inclined to axis of barrel.

115. Dreyse's needle gun, German, caliber .555, with saber bayonet.—Has brass band and tip. On frame "F. V. Dreyse, Sommerda." Quadruple leaf sight, hinged. Has a sliding and turning bolt, with longitudinal striker, operated by a spiral spring and carrying at the forward end a long needle. When the bolt is open the needle is drawn back within the bolt. With bolt closed, pulling the trigger releases the striker, and the needle passes through the powder at the base of the paper cartridge and strikes the fulminate beyond. Has only a full

cock, and cocking is performed by hand each time. Can not be fired until thumb piece for cocking is pushed back, locking bolt and preventing its rotation. It fires a paper cartridge, front ignition, the needle striking a pellet of fulminate in the base of the paper sabot which surrounds the ball. There is no gas check except that resulting from the mechanical fit of the bolt. This is the earliest self-primed cartridge adopted for military service, and the gun is the first example of the bolt system now so common in Europe. The bolt is pushed in and turned like a common door bolt to secure it. The Prussian needle gun described below is based on this system, which was invented in 1836.

116. Doersch's breech-loading rifle, caliber .61, with bayonet, German patent.—Loaned by Colt's Patent Fire Arms Manufacturing Company. Has a sliding and turning bolt with needle. Gun must be cocked by hand and cocking thumb piece pushed back and rotated. Bolt is rotated to right to engage lug against rim on rear portion of receiver, and has no safety lock for bolt mechanism.

117. Prussian needle gun, caliber .60, invented by Dreyse in 1838.—Presented by the Prussian Government to the United States in 1868. This gun was adopted by the Prussian Government in 1847.

118. Carbine of same system, caliber .577.—The front sight is protected by guards on either side projecting above the barrel. These guards stand away from the sight far enough not to interfere with aim. This device would be useful where no sight cover is used.

119. Dreyse's improved needle gun, caliber .605.—An improvement upon the Prussian needle gun. (See report of the Chief of Ordnance, 1873, and also Ordnance Memoranda No. 15.) Saves one motion in loading, the needle being automatically cocked in opening the piece.

120. French Chassepot carbine, caliber .45.—Handle bent down to be out of the way; paper cartridge. Bolt gun resembling the Prussian needle gun in principle. The gas check is a rubber washer on the end of the bolt. This is compressed axially by the powder pressure and forced against the sides of the chamber, being similar in principle to the De Bange gas check now used in heavy guns.

121. Green's bolt gun, caliber .535, paper cartridge, 1857.—Hammer underneath barrel. By depressing the spring in the rear of the bolt the handle of the bolt can be lifted and withdrawn. A piston, traversing the length of the bolt and attached to the handle, serves to pass the charge forward into place. The piston being then withdrawn, the bolt is turned and locked in place by two lugs at its forward end engaging with corresponding recesses in the receiver. The cartridges had the bullets in the rear so that there were always two bullets in the gun when loaded, the rear bullet serving as a gas check. Green used a wind-gauge slide on the rear sight and a barrel with an elliptical bore.

*122. *Lindner's breech-loading rifle carbine, caliber .57, 1854.*—Paper cartridge. This has a chamfered breechblock tilting upward on a hinge at rear in similar manner to the Hall. Encircling the breech of barrel in front of this block is a loose band with an overhang to hold front of breech pin down. Turning this band releases the breech pin and a spring underneath tilts it up. After loading, the breech piece is depressed and the band is turned to catch it in place. Eight hundred and ninety-two of these carbines were purchased by the United States Government for use during the civil war.

123. Whittemore's breech-loading rifle carbine, caliber .535.—No date. Paper cartridge, brass butt and guard. Depressing the lever underneath the breech releases a spring which raises the breech of the barrel upward so that the cartridge can be placed in. On pressing down the barrel, it catches to the stock and locks in a similar manner to the Hall.

124. Perry's shotgun, 1855, 15 bore.—Loaned by Colt's Patent Fire Arms Manufacturing Company. The breechblock is opened by a lever serving also as trigger guard, the front of the block being rotated upward.

*125. *Starr's carbine, caliber .54, paper cartridge, skeletonized to show breech action.*—By depressing the lever the brace in rear of the breechblock is drawn downward by means of a link connecting it with breechblock. The breechblock is simultaneously caused to revolve downward and backward. The piece is fired by an ordinary side lock. The face of the breechblock is countersunk annularly, so as to give a conical bearing against the butt of the barrel, probably to serve as gas-check. Twenty-five thousand six hundred and three of these arms were purchased for use in the Army during the civil war.

*126. *Cosmopolitan rifle carbine, caliber .50.*—By depressing the lever the front section of the breechblock slides back until a cylindrical tenon on its face is clear of the chamber. It then revolves about an axis in front and below it until the chamber is exposed. The strain of the discharge is transferred by the head of the lever to the abutment on the frame. The arm uses a paper or linen cartridge, ignited by a percussion cap. An apron above the block protects the parts from dust, etc., and helps to guide the cartridge in loading. Nine thousand three hundred and forty-two of these carbines were purchased by the United States Government for use during the civil war.

*127. *Smith carbine, caliber .52, paper cartridge.*—Barrel connected with butt by a hinge below, and held above by a spring on the barrel, stretching across the joint and fitting over a square lug on top of butt stock. Spring lifted by a lever underneath. Thirty thousand and sixty-two of these rifles purchased for use during the civil war. From Allegheny Arsenal.

*128. *Gallagher rifle carbine, caliber .51.*—Barrel opened at breech

by lever underneath, pushing barrel forward. Used in civil war. Twenty-seven thousand seven hundred and twenty-eight of these guns were purchased by the United States Government for use during the civil war.

*129. *Green's breech-loading rifle carbine, caliber .53, June 21, 1854.*—Paper cartridge. Maynard primer and brass butt plate. Opens by turning barrel to the right and pulling it forward, so that the charge can be placed in. Closes by reverse movement.

*130. *Gibbs breech-loading rifle carbine, caliber .52, 1863.*—Leaf sight, paper cartridge. Opened by pressing downward on a lever underneath. This moves the barrel forward and tilts up the rear end. One thousand and fifty-two of these carbines were purchased by the United States Government for use during the civil war.

*131. *Joslyn carbine rifle, caliber .54.*—The breech is closed by a plug at the forward end of the strap running backward on to the small of the stock. The shape of the plug is conical; it is loose upon the strap, and contains a split ring designed to be expanded by the force of the discharge against the sides of the seat of the mouth of the chamber to act as gas check. This expansion is effected by means of a conical plug, driven into the split ring by the discharge. This is similar to the gas check of the Williams gun described under cannon. The locking catch is so connected with the rear that the hammer can not fall while the breech is open. The breechblock is locked when closed by the locking catch at its rear end. Eleven thousand two hundred and sixty-one of these guns were purchased by the United States Government for use in the civil war.

*132. *Merrill breech-loading rifle carbine, caliber .54, 1863.*—Paper cartridge. Breech closed by a piston or plunger, which is attached by a link connection with a top lever hinged at its rear end to a rear extension of the barrel. When the lever is thrown forward and down it holds the plunger forward against the opening of the breech, the front end of lever being held by a sliding spring catch. Lifting the lever draws the plunger to the rear and exposes the breech. The Merrill rifle resembled the Jenks, described above, except as to manner of loading. It has a spring catch engaging with rear-sight base. Also an ordinary side lock meant for prepared paper or skin ammunition. No extractor used, as cartridge is all consumed. Breech plug faced with copper, probably to serve as gas check. Fourteen thousand four hundred and ninety-five Merrill carbines were purchased for use of the Army during the civil war.

133. Merrill, Latrobe, and Thomas breech-loading carbine, caliber .54, paper cartridge.—Brass butt-plate guard and band patch box on the butt stock of the gun; leaf sight hinged to the rear. Maynard primer. Faucet breechblock turned by a lever on side. When the breech is open a sliding rod in rear is used to force the cartridge through the block into the barrel.

134. Allen and Wheelock carbine, faucet breech.—The faucet turns on a horizontal axis in rear of the barrel, being operated by a long handle which extends to the rear of the long, small stock when the breech is closed. It is turned up vertically when the breech is opened. It is fired by a side lock striking on a nipple fixed to the housing of the breech on the right side.

135. Merrill musketoon, Latrobe and Thomas "rebel," caliber .54, paper cartridge.—Altered from Harpers Ferry rifle. Manufactured 1849. See lock plate. Leaf rear sight.

136. Bentley's breech-loading rifle, caliber .41, English, faucet breech.—Loaned by Colt's Patent Firearms Manufacturing Company. The breechblock rotates to right on vertical axis through its center by means of a lever under the stock. In the breechblock there is an arrangement for using a percussion cap.

137. Symmes breech-loading carbine, caliber .54.—Invented by Lieut. J. C. Symmes, Ordnance Department. Paper cartridge; Maynard primer attachment. Patch box in the stock. Two hundred Symmes carbines purchased in 1855. Breech closed by a block hinged in rear. Depressing a lever underneath throws up the block and exposes the end of the barrel through a hole in the block, allowing the cartridge to be pushed through. This is a modified form of faucet breech.

138. Tarpley breech-loading carbine, rebel, caliber .52.—Paper cartridge; brass frame. Breechblock swings upward on hinge at left side. Opened by pressing on a spring catch on the right, and throwing the breechblock over to the left side. Cartridge put in from the rear, level with the barrel.

139. Muzzle-loader converted to breechloader, .70 caliber, experimental.—Loaned by Colt's Patent Firearms Manufacturing Company. The breechblock has a longitudinal axis to the left of the barrel for rotation to the left. The block fits in an opening in the top of the barrel. The block is locked by a rotating plate on top, engaging front and rear in lugs on the barrel, and turned by a handle at the right side.

REPEATING ARMS.

Many of the single-fire breechloaders described above had magazines attached for percussion priming or for priming powder, and these are not included here; but the repeating guns described are not confined to those using self-primed cartridges, or even "fixed ammunition" with exterior primer. Early forms, not only for percussion but for flintlock guns, had separate magazines for powder, ball, and priming. Revolvers are repeating arms, but not magazine arms. The magazine guns proper are arranged according to form and position of the magazine—tubular magazines running through the butt stock or along the barrel, and what are called box magazines placed

under or beside the receiver, with cartridges arranged side by side instead of end to end. This last division is essentially the modern magazine gun, and it embraces quite a variety of forms—straight and curved, vertical and horizontal, drum shaped, etc., the latter being a natural development of the revolver. Just preceding the modern magazine guns examples are given illustrating their development from revolvers, tubular and gravity magazines, and from various devices for carrying cartridges for use with single-loaders. Following the description of box magazines illustrations are given of automatic and electric guns.

Among magazine guns a great variety of breech mechanisms is found, but no attempt is made to classify them by this feature, as in the description of single-loaders. In the development of magazine guns note must be taken of air guns, which first appeared about the year 1500, and which were even used in war by the Austrians in the latter part of the eighteenth century. Magazines for firearms appeared early in the eighteenth century, and they seem to have been based on magzines previously used on air guns. Even crossbows, however, were used with magazines containing extra "bolts" supplied automatically for rapid firing, and a Chinese crossbow of this nature for 20 "bolts" is shown in the artillery museum at Paris. In the first repeating guns here illustrated the barrel may be said to form its own magazine.

203. Ellis's repeating flintlock muzzle-loading rifle, caliber .54.—This illustrates one of the earliest forms of repeating arms. The barrel has three vents along the side of the breech, with a single lock made to slide back and forth to bring the pan opposite one vent after another. It was intended to put three loads in, one above another, with the wads between, the powder of each load coming opposite one of the vents. On firing the front charge the lock would be slipped back to the next vent, and so on, firing the rear charges in succession, if they had not gone off at the first shot.

204. Single-barrel pistol, percussion, firing two charges.—Similar to Ellis gun in method of loading, but provided with two hammers, one longer than the other, to reach two nipples, one in advance of the other. It was probably intended to force the bullets in tightly enough to prevent flame from front charge igniting the rear one.

REVOLVERS.

Some 60 specimens are shown. The earliest revolvers were match locks, but there are no specimens of these in the exhibit. The earlier forms had the cylinder extending the full length, and they required to be turned by hand. Though Colt's revolvers were the first ones generally used which turned the cylinder automatically, earlier forms show this improvement crudely. The chief point claimed in the original

Colt patent was the central fire, the nipples being placed in the axes of the barrels in the cylinder. An old revolver, shown by the Bandle Gun Company, of Cincinnati, has 4 barrels, each provided with a pan and cover for the single flintlock. One great objection to the revolver system for anything but pistols is the escape of gas at the joint between the cylinder and barrel, as this lessens the range. It is filled as readily as some of the tubular magazine guns. Savage's revolver, as well as Collier's, has a contrivance for pushing the cylinder against the barrel before firing, to shut off escape of gas.

205. Collier's revolver rifle, flintlock, caliber .53, 5 shots, 1818.—Loaned by Colt's Patent Firearms Manufacturing Company. Contains a cylinder, like that of the Colt's revolver, with 5 chambers, which are loaded from the muzzle and turned by hand. The mouth of each chamber is recessed sufficiently to receive the end of the barrel, which projects slightly to the rear. A spring behind the cylinder throws it forward when opposite to the barrel and closes the joint. Upon the back of the steel cover of the pan is formed a hollow chamber, containing a quantity of priming powder. By an automatic device, each time that the pan is shut a measured quantity of the powder is deposited in the pan, the valve in the bottom of the chamber being closed automatically by the forward movement of the pan. In the butt stock is a loading drift used to lengthen out the ramrod, which, on account of the pressure of the cylinder, can not be otherwise sufficiently extended.

206. Flintlock revolver carbine, pepper-box pattern, 8 shots.

207. Revolver percussion pistol (pepper-box), 6 shots.—See No. 5 on Board of Pistols, 105 of catalogue.

208. Old Japanese revolver, 3 barrels, percussion.—The history of this revolver is unknown. It is of very crude form, but the hammer and nipples for percussion cap indicate that it is not an antique. The handle is of awkward form. The barrels are remarkable from being wire wound and distinct from each other, and joined together without an exterior covering. They have to be turned by hand to come under the hammer.

209. Whittier revolver rifle, date about 1835.—Cylinder has to be turned by hand. Has a long single barrel in front of the revolving cylinder. Has concealed hammer with a cocking lever near trigger. Percussion cap used.

210. Cochran's revolver pistol, 1837. Revolving chambers; revolves by hand; hammer below; chambers extend radially from the center. Cylinder is a flat disk, with chambers in the curved surface, running radially from near the center. Revolved by hand. Hammer underneath. Paper cartridge, percussion. Contributed by Colt's Patent Fire-Arms Company.

211. Cochran revolver rifle, 1837.—Has a disk holding nine charges; revolved by hand. Hammer underneath. Disk taken out to charge

by throwing up strap which runs along top of stock. From Colt's Arms Company.

212. Swiss or Belgian parlor magazine rifle, 10 shots, caliber .35.—A disk containing 10 chambers radially disposed is pivoted in the prolongation of the barrel on a vertical axis. These chambers having been loaded with loose ammunition when off the piece, the disk is set in place and keyed there by drawing back the sliding barrel by means of the side lever until the tapered bolt of the barrel enters into the mouth of the nearest chamber. This movement of the side lever cocks a concealed hammer beneath the disk, which, when the trigger is pulled, rises to strike the percussion cap with which each chamber is primed. The barrel is then thrown forward again to allow the disk to be again turned for the next shot by hand. Its revolution is checked by a spring pin on the under side of the disk. The chasing on the lid of the chamber-piece is very well done, representing a wreath of vine leaves. Barrel hexagonal; fourteen grooves; serrated rifling; stock of ebony or of pear wood dyed black.

213. Two Colt's revolvers, of earliest pattern.—Used for paper ammunition. From Colt's Arms Company.

214. Colt's revolver rifle, early pattern.—From Colt's Arms Company.

215. Colt's revolver shotgun, No. 12 bore.—From Colt's Arms Company.

216. Colt's navy revolver, old model, with detachable extension stock.—The extension stock, formed like the butt stock of a gun, is intended to allow firing the revolver from the shoulder, and in this sample the stock is made hollow to inclose a canteen with an opening at the comb of the stock.

217. Colt's revolver rifle, 5 shots, with sword bayonet, caliber .56, 1857.—The cylinder is revolved automatically by cocking hammer. When at halfcock, cylinder can be revolved by hand and loaded, a rammer being adjusted just under stock.

218. Colt's revolver carbine, 5 shots, caliber .56, 1857.

219. Eight specimens of Colt's revolver.—Showing the progression from the earlier forms used with paper cartridges to the most recent used with metallic ammunition. Some show marks of alteration from old form to new.

220. Wesson & Leavitt revolver, caliber .35.—First revolver patented after Colt's. Made by Massachusetts Arms Company, Chicopee Falls, Mass.

221. French navy revolver, Lemat pattern, 9 shots, central barrel for buckshot.—The extremity of the hammer is made with a joint, so that it can be turned forward to fire the chambers, or turned down to fire the central barrel. Loaned by C. Breckenridge, Covington, Ky.

222. Three Joslyn revolvers, caliber .44, one skeletonized.

223. Eight specimens of Remington revolver.—Illustrating the development from the time of paper cartridges to to-day. Some forms have the Hay safety device, a slide passing up in front of the hammer to keep the latter up until the slide is withdrawn by pressing the trigger.

224. Beall revolver, caliber .44.—Bears close resemblance to the Remington.

225. Two Allen & Wheelock revolvers, caliber .44.—Its main difference from the ordinary form of the Colt revolver, or of the Remington, which it resembles in having the cylinder inclosed by the frame, consists in the position of the rammer lever, which is turned backward and bent so as to form the trigger guard.

226. Adams revolver (English), caliber .44, patented 1856.—A self-cocking revolver, the hammer being raised by pulling the trigger.

227. Four self-cocking Starr revolvers.—The trigger is double. By continuing to pull on the forward trigger, which raises the hammer and revolves the cylinder, the back of the trigger strikes against the front of a rear trigger and causes the hammer to fall.

228. Two Dreyse needle revolvers, caliber .35, self-cocking.

229. Four Savage revolvers, caliber .3625, self-cocking.—By pulling back the lever in the rear of the trigger the cylinder is first slightly retired from the barrel and then caused to revolve. The hammer is cocked at the same time. When the lever is released, the cylinder moves forward slightly, so that the mouth of the nearest chamber may embrace the butt of the barrel, made somewhat conical for this purpose. The cylinder is withdrawn by means of a toggle-joint connected in its rear end, which is lifted by a projection on the upper part of the lever. An arm attached to this end of the toggle reaches forward and operates the ratchet. The stop-ratchet is formed on the body of the cylinder, back of the cones. The operation of the moving parts, which is very interesting, may be readily seen by removing the plate on the left of the lock.

230. Pettengill's revolver, caliber .44, double-action, hammerless.

231. Two Lefaucheux revolvers (French), caliber .35, pin-fire.—By opening the gate on the right side, the rear chambers are exposed and an opportunity given to insert the cartridges. The empty cartridge shells are pushed out to the rear by sliding a rod on the frame. The cylinder stop consists of a pin plying back and forth in the face of the breech. It arrests the movement of the cylinder by striking against projections on the face of the cylinder between the chambers. In consequence of M. Lefaucheux's early invention of this pin-fire cartridge, this is one of the earliest breech-loading revolvers using metallic ammunition. The trigger folds up when not in use.

232. Christiensen revolver (Danish), caliber .45, pin-fire.—The hinged gate in rear of the right side of the cylinder allows the chamber to be

loaded with a pin-fire (Lefaucheux) cartridge. The stop operates against a series of inclined ratchet teeth formed on the body of the cylinder. The trigger folds up when not in use. The butt contains an oil cavity closed by a screw stopper which has an internal stem to take up the oil one drop at a time. An eye is formed in the frame immediately in the rear of the hammer, by which the pistol is fastened to the person by a lanyard.

233. Three Perrin revolvers (French), caliber .44.—The cartridges are inserted through the gate in the rear of the cylinder on the right. The tumbler is without any notch, the hammer falling at the moment that the "lift" of the trigger is accomplished. It may be kept off the cartridge by means of a wedge pressed in by a spring so as to block its fall. The wedge is out of the way when the hammer falls in firing. The pistol uses a central-fire cartridge, instead of the pin-fire Lefaucheux cartridge for which it was originally made.

234. Sharp's revolver, caliber .44.—Opened by swinging barrel sideways. Same as Wesson's, except in mode of opening.

235. Smith & Wesson revolver.—By raising the barrel latch in the rear of and above the cylinder the barrel may be turned down about a horizontal axis in front of the lower part of the cylinder. The barrel in turning down carries with it the cylinder, and at the same time a shaft running through the axle of the cylinder is driven to the rear, pushing out the empty shells by a projecting plate on the rear end. When pushed out far enough to remove the shells this extractor springs forward into place and gives room for inserting more cartridges.

236. Smith & Wesson revolver, caliber .43, Russian model.

237. Schofield, Smith & Wesson revolver, caliber .45, United States service pattern.—This arm differs principally from Smith & Wesson in the form of the extractor and of the barrel latch, the latter being hinged to the frame instead of the barrel of the cylinder catch. The height of the front sight is also reduced by placing it in a groove along the top of the barrel.

238. Board of pistols and revolvers loaned from Colt's Armory.—The numbers given below correspond to the numbers in the accompanying illustration of this board:

1. National Arms Company revolver, 6 shots, caliber .45, metal cartridge.
2. German revolver (Mauser), 6 shots, caliber .415, metal cartridge.
3. Leavitt's revolver, 7 shots, caliber .36, percussion cap.
4. German revolver (Mauser), 6 shots, caliber .415, metal cartridge, simultaneous ejection.
5. Pepper-box revolver, 8 shots, caliber .31, percussion cap.
6. Pepper-box revolver, 6 shots, caliber .31, percussion cap, hammer on bottom.
7. Belgian revolver (Lefaucheux), 6 shots, caliber .47, metal cartridge.
8. Massachusetts Arms Company revolver, Maynard primer, 6 shots, caliber .31.
9. French revolver, Abadie, caliber .35, metal cartridge, simultaneous ejection.
10. Remington revolver, 5 shots, caliber .31, percussion cap.

11. Slocum's revolver, 5 shots, caliber .32, metal cartridge.
12. Pocket pepper-box revolver, Rupertus, 1864, 8 shots, caliber .22, metal cartridge.
13. Belgian pocket revolver, 5 shots, caliber .32, double action, concealed hammer, folding trigger, "baby" metal cartridge.
14. Colt's pocket revolver, skeleton, 5 shots, caliber .27, paper cartridge.
15. Elliott's pocket pistol, 1860, 4 barrels, caliber .32, metal cartridge.
16. Sharp's pocket pistol, 1852, 4 barrels, caliber .22, metal cartridge.
17. Derringer, muzzle-loading, 1870, caliber .44.
18. Bacon & Co. pistol, caliber .32, metal cartridge.
19. English multibarrel rifled pistol, 4 diverging barrels, caliber .43, percussion cap.

239. Board of army and navy revolvers using paper cartridges:

21. Remington, caliber .44; used largely in the rebellion.
22. Remington, caliber .44.
23. Wesson & Leavitt, caliber .35; first revolver patented after Colt's; made by Massachusetts Arms Company, Chicopee Falls, Mass.
24. Joslyn, caliber .44, skeletonized; takes same cartridge as Colt's.
25. Beall, caliber .44; bears close resemblance to the Remington.
26. Colt, caliber .44; used for experimental bluing.
27. Adams (English), caliber .44; patented 1856.
28. Starr, caliber .44; self-cocking, set trigger.
29. Starr, caliber .44; self-cocking, set trigger.
30. Starr, caliber .44; self-cocking, set trigger.
31. Dreyse, needle, caliber .35.
32. Dreyse, needle, caliber .35.
33. Allen & Wheelock, caliber .44.
34. Allen & Wheelock, caliber .44.
35. Starr, caliber .44; self-cocking, set trigger.
36. Colt, caliber .44.
37. Joslyn, caliber .44.
38. Joslyn, caliber .44; skeletonized.
39. Savage, caliber .3625; self-cocking.
40. Pettengill, caliber .44.
41. Savage, caliber .3625; self-cocking.
42. Savage, caliber .3625; self-cocking.

240. Boards of army and navy revolvers using metallic cartridges:

43. Lefaucheux (French), caliber .35; pin fire.
44. Christensen (Danish), caliber .44; pin fire.
45. Remington, caliber .44; originally used with paper cartridge; converted for use of triangular metallic cartridge; experimental.
46. Remington, caliber .44; shows alterations for metallic ammunition.
47. Colt, caliber .44; originally used with paper cartridge; shows alterations for metallic ammunition and mode of ejecting shell.
48. Colt, caliber .44; shows alterations for metallic ammunition.
49. French, model 1873, caliber ——; made at St. Etienne.
50. Colt, caliber .36; shows alterations for metallic ammunition.
51. Colt, caliber .44; shows alterations for metallic ammunition.
52. Lefaucheux (French), caliber .44, pin fire.
53. Perrin (French), caliber .44.
54. Perrin (French), caliber .44.

55. Perrin (French), caliber .44.
56. Smith & Wesson, caliber .43, Russian model.
57. Schofield-Smith & Wesson, caliber .45, United States service pattern.
58. Smith & Wesson, caliber .44.
59. Sharp, caliber .44; private property.
60. Colt, caliber .45, United States service pattern.
61. Colt, caliber .45, United States service pattern, skeletonized; presented to National Armory Museum by General Franklin March 12, 1875.
62. Colt, caliber .44; shows alterations for metallic ammunition.
63. Colt, caliber .44; shows alterations for metallic ammunition and improved mode of ejecting shell.
64. Remington, caliber .44, pin fire, swinging shell extractor.
65. Remington, caliber .44; invented by Dr. Hay and submitted by Brig. Gen. R. Williams; Dr. Hay's patent safety lever; see arrangement near trigger.
66. Remington, caliber .44; shows alterations for metallic ammunition.
67. Remington, caliber .44; shows alterations for metallic ammunition.

241. Smith & Wesson's army revolver with Kelton's safety-stop attachment.—As shown in figure 6, the handle of the revolver has a thumb piece on the right. This serves two purposes: first, it steadies the revolver by giving a firm grasp with the aid of the thumb; second, it prevents firing the piece until the trigger is pulled. For this purpose the thumb piece is hinged at the forward end on a shaft, which extends into the frame of the handle and keeps the hammer from falling until the thumb piece is pressed down. This is the invention of Bvt. Brig. Gen. J. C. Kelton, U. S. A.

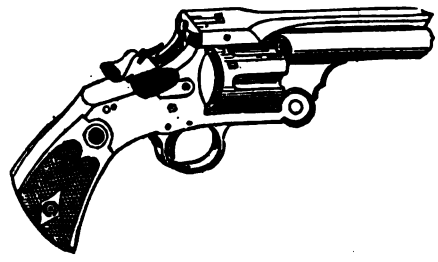


FIG. 6.

242. Kelton's cartridge pack for Smith & Wesson revolvers.—This is shown in figures 7 and 8. Figure 7 shows the package, and figure 8 shows it partially inserted in the barrel of the cylinder. The cartridges are arranged around a central stem, and held by a paper band, or by a brass strap with a simple catch. The packages are carried in cylindrical boxes attached to the waist or shoulder belt, and when the revolver is opened they can be readily taken from the belt and pushed into the cylinder. The band or strap is readily loosened, and the central stem falls out. This gives a ready means of reloading the cylinder.

FIG. 7.

243. New Colt double-action revolver, caliber .38, with simultaneous ejector.—Adopted for United States service. This arm has been tested by several troop commanders with very favorable results, and it is considered a decided improvement on the .45 caliber now in use. The special peculiarity of this revolver consists in an arrangement for

allowing the cylinder, by the withdrawal of a spring catch at the left side of the frame, to be swung outward to the left upon a crane, which has an axis at the lower part of the frame parallel to the bore of the revolver. This permits the simultaneous ejection of all the shells by means of a rod sliding through the center of the cylinder, and allows the free insertion of new cartridges. The cylinder is then swung back into the frame and held in place by the spring catch. The catch is so placed as to be readily withdrawn by the thumb while the hand still remains upon the grip of the revolver. The cylinder can not be swung from its place in the frame except when the trigger is forward in its normal position, and the trigger can not be pulled when the cylinder is thrown out, being firmly held by the rear end of the spindle so that no motion of the hammer is possible. The trigger spring serves also to produce the rebound of the hammer. A dog and ratchet hold the cylinder absolutely firm at the moment of firing. In other respects the revolver does not essentially differ from those previously described. The tendency to reduction of caliber is shown in revolvers as well as rifles, the only argument in favor of the larger calibers for cavalry being the shock that is required to stop, at close quarters, a horse going at full speed, and many cavalry officers still favor the larger calibers.

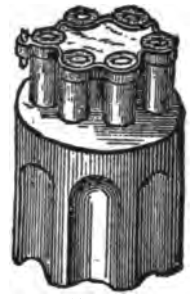


FIG. 8.

Tubular magazines in the butt stock.

The earliest example of this kind known is a flintlock gun of the eighteenth century. It had two tubular magazines running lengthwise of the butt stock, as in later models, one holding powder for the charge and the other powder for priming, the bullets being inserted singly. A revolving disk, turning, like the Cochran, round an axis perpendicular to the barrel, but horizontal instead of vertical, served to close the breech and the tubes. A chamber in the circumference allowed the insertion of a ball from underneath the gun. The disk was then turned to carry the hole past the magazine openings, muzzle of gun held down to let the powder drop in, and was then set to bring the chamber opposite the barrel.

244. Spencer carbine, old model, caliber .52, skeletonized.*—This gun was introduced in 1860. It was the earliest magazine gun used in actual war. Ninety-four thousand one hundred and fifty-six were purchased for use in the Army during the civil war. Used a rim-fire metallic cartridge. A lever underneath, swinging down and forward, draws down the breechblock and swings it backward far enough for a cartridge to slip over the block from the magazine in rear, a spring finger above the mouth of the magazine keeping the cartridge from

slipping out. Swinging the lever backward pushes the cartridge in and closes the breech. Fired by an independent hammer striking a slide in the block and driving it against the rim of cartridge. By a button underneath, the swing of the lever can be limited so that a cartridge will not be admitted from the magazine, and the gun can then be used as a single loader. A narrow plate hinged to the block serves as extractor, and the shell is forced out by sliding up the inclined finger which covers the magazine. A tube containing a spiral spring can be drawn out from the rear, allowing cartridges to be dropped into the magazine. Returning the tube to place brings the pressure of the spring upon the cartridges to force them forward. The spring has a head, or "follower," at the end to bear upon the cartridge, and this is common to all spring magazines.

To facilitate the filling of the magazine a species of charger was used, invented by Gen. Erastus Blakeslee, of Connecticut. This was a tin tube carried full of cartridges, placed end to end, from which the cartridges could be poured into the magazine when the spring tube was removed. A number of these tubes were carried by the soldier, packed in a leather case slung over the shoulder and steadied by means of the waist belt under the left arm. The cavalry box held 8 tubes and the infantry box held 13. One of these boxes filed with chargers was contributed to the exhibit by the inventor. It is the forerunner of the modern "clip" or charger used with box magazines, but in the latter the cartridges are placed side by side, forming a more convenient package and allowing the insertion of the finger to force the cartridges out.

245. Spencer repeating rifle, caliber .50, altered from carbine.—Same system as above.

246. Scott or Triplett magazine rifle, caliber .50, about 1870, Meriden Manufacturing Company, Meriden.—The magazine in butt stock; barrel revolves on parallel axis beneath it until opposite mouth of magazine, when it receives its charge. The extractor is worked by the rotation of the barrel.

247. Clemens magazine rifle, "Springfield system," 1878.—The magazine in this gun is placed in a groove in the left side of the butt stock, and it runs up to the side wall of the receiver, which has an opening to allow cartridges to slip obliquely from the magazine toward the firing chamber. A coiled spring at the side of the magazine works a flexible plunger to force the cartridges forward. Rather complicated mechanism, somewhat on the order of the first Allin model for the Springfield, is needed to throw the empty shell clear of the magazine and draw a cartridge from the magazine to the chamber. This gun shows a hammerless breechblock. It is converted from the regular block with little exterior change. A side lever, as in the Kelton hammerless gun above described, pushes back the firing pin and compresses

a spring in the block; but instead of having a sear below, the firing pin projects from the rear of the block as in the service model, and a shoulder there catches on a spring plate which is pressed out by movement of the trigger, releasing the firing pin. The description of this gun in Report of Chief of Ordnance for 1878 does not refer to the "hammerless" device. Other attempts to make a magazine gun of the Springfield are there noted.

248. Hotchkiss magazine rifle, caliber .45.—See Report of Chief of Ordnance for 1882. This gun was introduced about 1879. It is a bolt gun similar to the Mauser. The slot in the receiver is curved at its junction with the front and rear shoulders. The bolt is hence gently checked just before it is pushed home, preventing shock on the head of the cartridge, and making the operation more continuous than with square shoulders. The front curve also cams the bolt backward in beginning to open, and so starts the shell, which can then be readily drawn out. This action, now used in other bolt guns, was claimed by Hotchkiss as his invention. The magazine, in the butt stock like the Spencer, runs under instead of over the breech-piece, and brings the cartridge into the receiver through an inclined opening in the bottom. A spiral spring is used with follower. Center-fire cartridges are used. To insert them the bolt has to be opened, and they are pushed in through the chamber, endwise, singly, butt end first. By a lever at one side the bolt can be locked shut for security, and the hammer held from striking. A lever at the other side shuts off the magazine when necessary for use as a single loader. It is a remarkably simple gun, and it avoids having an extra piece to serve as carrier for transfer of cartridges from the magazine. A peculiar feature is a trigger with a hollow or curved stem where it passes round the magazine. Stops connected with the trigger check and release cartridges in the magazine at the proper time.

249. Chaffee Reece magazine rifle, caliber .45, 1881.—See Report of Chief of Ordnance, 1882. The position of the magazine is nearly the same as in the Hotchkiss, but in place of having a spring in the magazine the cartridges are forced forward by studs on a bar at the side of the magazine tube. This bar is moved back and forth by a projection on the bolt. Another bar, which does not move lengthwise, has corresponding studs, and it is kept pressed in by a spring, the studs on this bar keeping cartridges from slipping back when the first bar moves back. The reciprocating bar thus draws the cartridges forward, by regular successive steps, distances equal to their own length. The front cartridge, before the breech is opened, lies in a hollow under the bolt far enough forward to be pushed up and into the chamber as the bolt is pushed in after opening. A hinged gate in the butt plate can be thrown open to admit cartridges in filling the magazine tube. This gate, in opening, acts upon the studded rods to force them out from

the tube and allow cartridges to be dropped clear in without striking the studs. This gun, arranged for small-caliber cartridges, was tested by the United States magazine gun board of 1892.

TUBULAR MAGAZINES ALONG THE BARREL.

250. Henry magazine rifle, sliding carrier block, caliber .42, old model.—This system was invented about 1850, but it was slow in coming into use, until developed about 1866 into the form of the Winchester gun next described. The gun is operated by a lever swinging forward below. This acts on an elbow joint which works the bolt back and forth. An arm connected with the lever causes a carrier block to slide up and down, transferring the cartridges from the level of the magazine to that of the barrel when the bolt is back, and dropping the block when the bolt is forward, and a cartridge pushed into the chamber. The magazine is charged from the front. The tube is in two sections, the muzzle part made to swing round to the side to clear the mouth of the magazine tube, the spring being first pushed up into this part by means of a thumb piece attached to the follower, and projecting through a slot cut lengthwise in the magazine tube. Cartridges can then be dropped into the tube. A magazine under the barrel gives room for more cartridges than one in the butt stock.

251. Winchester magazine rifle, caliber .45, military model, 1876.—This differs from the Henry gun, from which it was developed, mainly in the method of filling the magazine. Instead of having a movable muzzle section the tube is continuous, and an opening at the rear, covered by a spring plate, allows the insertion of cartridges one at a time even when the gun is loaded. No other means of loading is provided than this method through the magazine. This gun attracted much attention abroad when first made, about 1866, and it was adopted in Switzerland, where it was afterwards displaced by the Vetterlin, next described, constructed on the same magazine principle. The Winchester is very popular for sporting purposes, where small cartridges can be used. Its operation depends on good workmanship, and it is a fine piece of mechanism. The length of the breech system prevents its being used to best effect for long cartridges.

252. Swiss Vetterlin magazine rifle, caliber .40, about 1868, adopted by Switzerland for its corps d'élite.—This is a simple bolt gun, the bolt operating a sliding carrier block like that of the Winchester, from which magazine system it is derived. The same remarks as to filling the magazine and loading apply to this as to the Winchester. The bolt differs from the Mauser bolt in having the handle near the rear and bent down by the side of the stock, two lugs on the turning part of the bolt, near the rear, catching the shoulders in the breech frame. This rear position of the handle is an advantage in magazine guns,

The firing spring is spiral, as in the Mauser, but made large and heavy, though short, and placed in the rear instead of the front part of the bolt. This makes an enlargement in rear and gives a clumsy look.

253. Stickney's breech-loading carbine, caliber .42, magazine on right side of barrel, 1872.—Loaned by Colt's Patent Firearms Manufacturing Company. The cartridge carrier for this gun is worked by hand. It is a grooved block hinged on a longitudinal axis at the side, between the barrel and the magazine tube. When swung over to the right it receives the cartridge, which is pushed back from the magazine into the groove. Then tilting the carrier over transfers the cartridge to the receiver. The cartridge is forced home by a square bolt attached to the hammer, and fired by a firing pin which is contained in the bolt.

*254. *Ball's breech-loading magazine carbine, caliber .50, 1863.*—The magazine, which lies beneath the barrel, is loaded from the rear through an aperture in the side of the receiver. The breech mechanism is operated by a lever below. The breechblock is formed into a spoon at the front end, so that when the block is closed it forms not only the rear of the cartridge chamber, but a portion of its bottom. When the lever is depressed the breechblock is drawn to the rear and the front end is tilted downward so that a cartridge is admitted into the spoon from the tubular magazine under the barrel, a groove in the rear under the spoon serving to hold the flange of the cartridge shell. A reverse motion of the lever tilts up the block to the level of the barrel and pushes it forward, inserting the bullet end of the cartridge. The empty shell after firing is drawn back by the breechblock and lowered to the level of the loading opening, where it is flipped out sidewise by a lever which is struck by the breechblock. The breechblock is so arranged that, once closed, it can not be opened until after the hammer has fallen. This is intended to prevent loss of ammunition by withdrawal before firing. The piece is fired by a side lock. One thousand and two of these arms were purchased for the Army during the civil war.

255. Smith's punch-lock rifle, with magazines for paper cartridges and percussion pellets, 1851.—Loaned by Mr. E. Thomas, Chicago, Ill. This is a bolt gun operated by a lever underneath, as in the Henry, but the bolt is pushed forward and back by a short arm on the lever, and it is secured for firing by a brace hinged in rear and forced up behind the bolt. When the bolt is drawn back a cartridge from the tubular magazine under the barrel is carried up by a rocking spoon or carrier. This magazine used paper cartridges, fixed. They were fired by means of a side punch lock, the point of hammer dropping into a hole in the top of the breech bolt. Into this hole pellets of percussion powder were dropped from a small magazine under which the

bolt passed in moving back and forth. The flame communicated with the powder through an aperture in the end of the bolt.

256. Ward-Burton magazine rifle, caliber .45, 1873, rocking carrier.—The bolt mechanism of this gun is the same as that of the Ward-Burton single-loader above described. Like that gun, the handle is placed at the rear of the bolt, and a stop is provided to hold the handle half turned, thereby giving a halfcock. The magazine is a tube under the barrel with spring and follower as above described, but instead of a sliding carrier block, a rocking carrier of spoon shape is used. This spoon is made to rock on horizontal bearings at the rear. Its front end is forced down by the bolt in moving forward and up by the bolt in moving backward, striking projections at the rear end. The spoon when down receives a cartridge from the magazine and when up it holds the cartridge inclined upward toward the chamber, about at the position and slope of the front cartridge in the Hotchkiss, with the flange end raised sufficiently for the bolt to strike the upper edge in going forward and so push the cartridge into the chamber. A side lever operates to hold the spoon up and cut off the magazine when desired for use of gun as single-loader. Cartridges are inserted into the magazine through an opening under the breechblock. Cartridges are put in endwise, singly, point first. The magazine mechanism is indicated in the cuts illustrating the new German and French magazine guns below described, to which the remarks about loading, etc., also apply. Brought before the United States board of magazine guns of 1874.

257. Remington-Keene magazine rifle, caliber .45, tested by magazine gun board of 1882.—The breech mechanism of this gun is a sliding and turning bolt, not differing materially from the ordinary bolt, the locking being done by having the handle turn down in front of a shoulder on the side. The principal peculiarity of the bolt lies in having a pivoted cocking piece in rear, by means of which the firing pin, concealed in the bolt in the usual way, can be drawn back and the piece cocked without opening the bolt. A halfcock and safety mechanism are provided. The tubular magazine is under the barrel, as in the Ward-Burton, and the cartridge is raised in a similar manner by means of a rocking spoon operated by the bolt. The front part of the bolt turns with the handle, and when the bolt is unlocked the extractor rides around ahead of the cartridge. The magazine can be filled in any position of the bolt by inserting cartridges underneath the carrier. See report of Chief of Ordnance for 1882.

258. Mauser magazine gun, German model, caliber .43.—This is practically the Mauser single-loading mechanism with a magazine of the Ward-Burton type, having a rocking carrier or spoon. This is commonly known as the Kropatcheck system, which, however, was not known until about 1878, while the Ward-Burton was tried in this

country in 1873. A projection below the nose of the spoon serves to prevent cartridges from slipping under the spoon from the magazine, and a detent operates when the spoon is down to prevent a second cartridge from following the first into the spoon. A cut-off operates in a similar manner as in the Ward Burton gun. The rifle is 4 feet 3 inches long, and with the bayonet 5 feet 11 inches long. With the magazine empty the gun weighs about 10 pounds; with it filled, about 11 pounds. The bayonet weighs 1.76 pounds. The trigger mechanism is so arranged that a gradual pull on the trigger finally disengages the tumbler and permits the firing-pin to fly forward. The magazine holds 8 cartridges end to end. The service cartridge weighs 663 grains. It is 3.07 inches long. Later cartridges contain 89½ grains of powder. Reduction of caliber is now going on, and its advantages will be discussed under ammunition. The French gun next described is of reduced caliber. A box magazine gun, described later on, has replaced this gun in the German army.

259. The Lebel magazine gun, French model, caliber .304, represented only by drawings and description.—This is practically the French Gras rifle fitted with the Kropatcheck (or Ward Burton) magazine, and the same general remarks apply here as to the Mauser gun just described. The new bolt has double lugs, as in the Lee bolt, to take up the recoil on both sides the receiver. One figure shows the spoon down, with a cartridge lying in it received from the magazine. The bolt is partly pulled back, drawing out an empty shell, in the position just before tilting up the spoon with the new cartridge to the position shown in the other figure. The Berthier box-magazine gun has replaced this in great measure in the French army. For description of cartridge and results with it see under ammunition.

260. Kropatscheck, Portugal, caliber .315.—This arm has been officially adopted and issued to the army of Portugal. The magazine, holding 8 cartridges, is tubular and lies under the barrel. It is charged with single cartridges only through the receiver, and a cut-off is provided for the magazine. A spoon-shaped cartridge carrier elevates the cartridge from the magazine, as above described. The breech is closed by a bolt not differing materially from others above described. This gun has a cut-off for the magazine, and a safety locking device for the bolt. This gun was tested by the United States Magazine Gun Board of 1892.

261. Murata, Japan, caliber .315.—This arm is adopted by the Government of Japan. The magazine lies under the barrel in a channel in the stock, has a cut-off and can only be charged with single cartridges through the receiver. While differing in some of the details of construction and dimensions, this arm is very similar in both its breech and magazine mechanism to the Kropatscheck, described above. It has no safety lock, and the piece must be carried at full

cock after it has been loaded. This gun and the Kropatscheck, above described, were the only new tubular magazine guns brought up for test before the United States Magazine Gun Board of 1892. A Chaffee-Reece gun of caliber .30 was, however, tested. All the rest had box magazines. Before the Magazine Gun Board of 1882 all had tubular magazines except two; this shows the tendency toward box magazines for military guns.

262. Spencer repeating shotgun, 12 bore, 1881.—The breechblock in this gun resembles the Peabody, it being hinged in rear, and made to move up and down in front. Its special peculiarity lies in the arrangement for operating the block by means of a sliding handle on the magazine tube under the barrel. This handle is connected with flat bars, which extend to the rear, into the receiver, and along the breechblock. A stud on the inner side of one rod fits in an inclined groove in the side of the breechblock, so that sliding the handle back wedges down the block to open the breech. Immediately after this, an extractor is operated by the bar on the other side to remove the empty shell. When the handle is well back the block is thrown up by a spring, tossing the shell out above. While the block is up, a cartridge underneath, received from the magazine below the barrel, is pushed in by moving forward the slide, and the breech is closed. The magazine is filled from underneath the breechblock.

263. Colt's magazine rifle, caliber .22, 1887.—This gun is also operated by a handle sliding on the magazine tube under the barrel, but the breech action is a bolt system, instead of the falling block. A bar, attached to the slide, works a lever connected with a cam latch, which is hinged at its forward end to the under side of the bolt toward the rear. When the bolt is closed the rear end of this cam latch drops into a depression under the bolt in the bottom of the frame, and abuts against a shoulder in the frame, securing the bolt. Drawing back the handle raises the cam latch over the shoulder and then pushes back the bolt so freed. Forcing the handle to the front draws the bolt forward and finally swings the cam latch down again, locking the bolt. A spring extractor on the bolt withdraws the empty shell. A sliding carrier block, moving like that in the Winchester and Vetterlin, transfers cartridges from the magazine. The rear end of the magazine tube can be swung slightly to the right to insert cartridges, a spring plate securing them from springing out. This gun was used during the Exposition, in the shooting gallery of the War Department, in determining practically the velocity of projectiles. Loaned by B. Kittredge Arms Company, Cincinnati.

264. Winchester repeating shotgun.—This has a breechblock operating in a similar manner to that of the Spencer magazine gun described at the beginning of magazine guns, and it is worked by a similar lever underneath; but the magazine is under the barrel, and when the breech-

block is revolved backward a spoon carrier lifts the cartridge from the magazine to the level of the barrel. Closing the breech forces home the cartridge.

265. Burgess repeating shotgun.—The special peculiarity of this gun is its operation by a handle embracing and sliding along the small of the stock. This handle carries with it the trigger and trigger guard, so that the trigger hand may rest continually on the trigger. The breech is closed by a bolt, which is secured by a brace hinged to it and connected with the slide by a link, so that a motion of the handle to the rear unlocks the bolt and pulls it out; then operates a rocking carrier to bring the cartridge up from the tubular magazine below. Sliding the handle forward closes the breech and loads the gun, it being impossible to fire until the bolt is secure. There is no special peculiarity about the magazine, and this breech action, like that of the Spencer repeating shotgun, is equally applicable to box magazines.

Review of magazine guns.

The earlier magazines, of tubular form on account of the difficulties in refilling them, were almost of necessity kept full and held in reserve to await some special crisis in the battle; and the added weight of the cartridges had to be carried on the gun. The essential purpose of the modern form is to provide a means for so rapidly renewing the supply that it is unnecessary, as a rule, to keep cartridges in the magazine and on the gun. The box form of magazine, therefore, has been universally adopted, because that form holds the cartridges in the most compact and convenient manner, and because with such a form it can be replaced or refilled the most readily. This makes the use of a compact and convenient magazine filler possible, and the arrangement of cartridges side by side prevents the possibility of explosion of a cartridge by having the bullet of one cartridge rest against the primer of another, as in tubular magazines.

A marked distinction is sometimes drawn between magazine guns and repeaters among the modern guns, as if there were an essential difference in the method of charging the magazine; the term "repeaters" being applied to those arms which can not be used as single loaders while the magazine is charged. As this difference, however, depends merely on whether a cut-off is used or not, and as a cut-off can be used with any style of magazine, this difference is one of choice rather than of necessity, and all the new arms afford the facilities for rapid, continuous fire.

In many instances the cut-off is abandoned with a direct view to controlling the magazine fire by making the difference between single fire and fire from the magazine as distinct as possible. For this purpose the use of the packing case or clip affords an opportunity for the officers to observe the rate at which the magazines are used.

The United States, though nearly the last nation to definitely adopt a magazine gun for its armament, can claim for its inventors the first practical development of magazine guns for war purposes, and it was the first nation to make use of them in war, the Henry, Spencer, and Ball magazines being used during the war of the rebellion. The modern box magazine also owes its inception to American inventors, and the most improved modern systems vary but slightly from the originals.

There is no doubt that the introduction of this form of magazine has led to the general adoption of the magazine gun for the armament of troops, the military powers having apparently waited only until a magazine arm could be obtained which would not merely serve for a temporary reserve, leaving the gun no better than a single loader when the magazine was exhausted, but which could be quickly refilled for successive emergencies, however rapidly they might occur, and which would even increase the rapidity of continuous fire. The box magazine is the only kind with which more rapid continuous fire can be maintained than with the best single loaders.

The great impulse to the adoption of magazine guns was given by the change of armament demanded by the adoption of smaller caliber and smokeless powder for military arms. This lessened one objection which has always been urged against every step toward improvement in the rapidity with which they could be fired—that sufficient ammunition could not be provided to supply the increased demand; for the weight of the arm is reduced as well as the weight of the cartridge, so that for the same weight nearly double as many cartridges can be carried as before. The increase in accuracy of fire, due to having longer time to aim, has greatly developed the effect of modern arms, so that there is less waste of ammunition. The magazine gun is now fully accepted, and the contest is now over the adoption of automatic guns, giving still greater rapidity of fire. A recent authority says on this subject as follows:

To sum up, we believe that the arguments opposed to the adoption of rapid-firing rifles are but a continuation of those raised against the adoption of the percussion gun and the magazine gun, and that, as in those cases, experience or a conscientious investigation of the matter will demonstrate that the result can not be doubtful, but very sure, and that the education of the soldier, modified to agree with the conditions, will keep the waste of ammunition from being as great as claimed, or, what is the same thing, that the same end will be attained with the same number of shots as in ordinary fire; simply in this case varying the time, which will be shortened in proportion to the rapidity.

The sights of modern military arms are treated under a separate head in the report, and the cartridges are described under the head of ammunition, with some discussion of ballistic effects of the modern rifle.

A table is appended giving the elements of the infantry rifles of different nations, this table being drawn from a paper prepared by Capt. S. E. Blunt, Ordnance Department, United States Army, a member of the recent magazine-gun boards.

Infantry rifles of different nations.

Nation.	Name of gun.	Type.	Magazine.	Cartridges in magazine.	Barrel.		Grooves.	
					Length.	Caliber.	Number.	Depth.
					Inches.	*Inches.*		*Inches.*
Argentina	Mauser, 1891	Repeater	Central	5	29.1	0.301	4	0.003
Austria	Mannlicher, 1888	do	do	5	30.1	.315	4	.008
Belgium	Mauser, 1889	do	do	5	30.7	.301	4	.003
Bulgaria	Mannlicher, 1888	do	do	5	30.1	.315	4	.008
Chile	do	do	do	5	30.1	.315	4	.008
Denmark	Krag-Jorgensen, 1889	Cut-off	do	5	32.9	.315	6	.006
England	Lee-Speed, 1891	do	do	10	30.2	.303	7	.004
France	Lebel, 1886	do	Tubular	8	31.5	.315	4	.006
Do	Berthier, 1891	Repeater	Central	4	.....	.301	4	.006
Germany	Model 1888	do	do	5	29.1	.311	4	.005
Holland	Mannlicher, 1892	do	do	5	31.1	.256	4	.....
Italy	Carcano, 1892	do	do	5	28.8	.256	4	.006
Japan	Murata, 1887	Cut-off	Tubular	8	29.6	.315	4	.004
Norway	Krag-Jorgensen, 1893	do	Central	5	31.1	.256	4	.....
Portugal	Kropatschek	do	Tubular	8	32.3	.315	4	.004
Roumania	Mannlicher, 1891	Repeater	Central	5	28.6	.256	4	.004
Russia	Mouzin, 1891	do	do	5	.....	.300	4	.....
Spain	Mauser, 1891	Cut-off	do	5	.....	.276	4	.005
Switzerland	Schmidt, 1889	do	do	12	30.7	.295	3	.004
Turkey[a]	Mauser, 1890	Repeater	do	5	28.4	.301	.....	.....
United States	Model 1892	Cut-off	do	5	30	.300	4	.004

[a] It is reported that Turkey has just adopted the Krag-Jorgensen gun of the same model as the United States arm.

Infantry rifles of different nations—Continued.

Nation.	Name of gun.	Type.	Grooves.		Weight.				Kind of powder.	Initial velocity.
			Width in terms of lands.	Twist.	Gun.	Bullet.	Powder.	100 cartridges as carried.		
				Inches.	*Pounds.*	*Grains.*	*Grains.*	*Pounds.*		
Argentina	Mauser, 1891	Repeater	2½	9.84	8.8	211	41	6.30	Smokeless	2,120
Austria	Mannlicher, 1888	do	1½	9.84	10.1	235	40	7.16	Schwab-Rubin	2,060
Belgium	Mauser, 1889	do	2½	9.84	8.8	216	43	6.41	Wetteren	2,170
Bulgaria	Mannlicher, 1888	do	1½	9.84	10.1	235	40	7.16	Smokeless	2,060
Chile	do	do	1½	9.84	10.1	235	40	7.16	do	2,060
Denmark	Krag-Jorgensen, 1889	Cut-off	2	11.81	9.5	235	76	7	Black	1,770
England	Lee-Speed, 1891	do	5	10	9.4	214	66	6.50	Black, Cordite	1,830
France	Lebel, 1886	do	2	9.49	9.3	231	46	6.15	Poudre B	2,050
Do	Berthier, 1891	Repeater	2	9.45	8.5	205	33	6.30	Smokeless	2,130
Germany	Model 1888	do	3	9.45	8.5	226	38	6.83	Nobel	2,050
Holland	Mannlicher, 1892	do	(b)	7.87	9.1	165	36	5.43	Smokeless	2,300
Italy	Carcano, 1892	do		7.87	8.5	170	34	6	Ballistite	2,320
Japan	Murata, 1887	Cut-off	Equal	11	9	238	36	6.69	Smokeless	1,850
Norway	Krag-Jorgensen, 1893	do		7.87	8.7	156	35		do	2,300
Portugal	Kropatschek	do	Equal	11	10.2	245	70	7.70	Black	1,760
Roumania	Mannlicher, 1891	Repeater	(b)	7.87	8.7	165	36	5.43	Smokeless	2,260
Russia	Mouzin, 1891	do		9	9.5	213	33	6.12	Kazan factory	2,100
Spain	Mauser, 1891	Cut-off		9.80	8.6	178	38		Smokeless	2,290
Switzerland	Schmidt, 1889	do	(b)	10.63	10.4	215	30	6.53	P. C., 1889	1,920
Turkey[a]	Mauser, 1890	Repeater			8.8	213	41	6.34	Smokeless	2,110
United States	Model 1892	Cut-off	3	10	8.7	220	37	5.86	Wetteren	2,000

[a] It is reported that Turkey has just adopted the Krag-Jorgensen gun of the same model as the United States arm.

[b] Nearly equal.

Development of the modern box magazine.

The accepted forms of box magazines of to-day are fitted with spring followers or some positive feed to force the cartridges sidewise to the mouth, with no intermediate "carrier" to convey them to the receiver. Notwithstanding the conceded advantage of magazine guns of the tubular type, that of a reserve for certain emergencies, none of them in long-continued fire could exceed the best single-loaders in the number of shots delivered, the long time that it took to refill the magazine offsetting the great gain in rapidity of loading the gun from it. In this stage of development it was thought that the complicated mechanism of magazine guns might be avoided by changes in the method of carrying the cartridges for use with single-loading guns, the aim being to make it easier for the soldier to get at the cartridges. This gave rise to "quick loaders," so called. Several early box magazines were dependent on gravity, as in the cartridge cases for machine guns, and attempts were also made to combine box with tubular magazines.

266. Quick loaders.—These are devices for carrying extra cartridges on a single-loading gun in a convenient position to be seized successively for loading the gun by hand. They are rather substitutes for magazines than magazines proper, but they form a link between single-loaders and box magazines. The detachable principle is illustrated in some of them, and in several forms the cartridges are forced laterally by means of a spring to present them successively at the mouth.

(a) Krnka quick loader: The best known of these is the one invented by the gunmaker Krnka, of Prague, whose conversion of the muzzle-loading guns to breechloaders was adopted in Russia. The Krnka quick loader first came into prominence in the Turco-Russian war, 1877–78. It consisted of a longitudinal box of pasteboard open at the top. Within it was divided by partitions into spaces for ten cartridges, two of these partitions, the second from each end, being formed of a double spring to press against the cartridges, which were inserted bullet down. The cartridges came packed in these boxes, which were carried on the belt of the soldier. A movable spring frame on the gun served to hold the boxes for use. In the first form, which appeared in 1872, Krnka's device, called by him a rapid-fire regulator, consisted of a pasteboard box with plain, thin partitions, and it had no device for securing it to the gun, the soldier holding it between the gun and the left hand, which grasped it. Similar forms devised in America about the time of this earlier invention are described below.

(b) Colonel Benton's quick loader, fixed, 1870, for Springfield rifle: The cartridges are placed point down in holes in the stock, which is enlarged at the left of the receiver, the side of the breechblock having a projecting ledge to hold the cartridges in.

(c) General Hagner's quick loader, fixed, 1874: A perforated block under the stock holds several cartridges, points to the rear.

(d) Stillman's quick loader, fixed, 1874: The cartridges are arranged in a row of holes in the top of the butt stock, and are protected by a hinged or a swinging cover.

(e) Merrill's quick loader, fixed, 1884: A mortise is cut in the top of the stock, and this is covered except at the front end. A spring within presses a follower forward to hold any cartridges that may be put in, and to keep them near the opening ready to hand. A detachable quick loader acting on the same principle is also illustrated.

(f) Colonel Benton's detachable quick loader, 1873: This is a perforated wooden block which can be attached to catches on the right side of the stock near the receiver by means of a lever fastened to the block. It is intended to be preserved and refilled.

(g) Captain Metcalfe's detachable quick loader and cartridge packing block, 1874: This differs mainly from Colonel Benton's in the method of attachment to the gun, having the block itself free from mechanism, and in making the block to serve for packing cartridges at the armory for transportation. It holds eight cartridges. It is intended to be thrown away when emptied.

(h) Elliott's detachable quick loader, 1871–72: This has the cartridges arranged in a spiral drum and moved by a spring, as in the Schulhoff magazine, and it introduces the principle used in modern magazines of pushing the cartridges sidewise toward the mouth, but taking them out endwise. No provision was made for automatic transfer of cartridges to the firing chamber of the gun.

(i) Tyler's spiral magazine for revolvers, 1853: This is properly a "quick loader." It consists of a drum in which the cartridges are arranged parallel to the axis and carried round between spiral partitions by means of a spring. The drum is attached to a revolver in front of the cylinder into which the cartridges are successively pushed by a plunger sliding under the barrel.

267. Swingle revolving repeating rifle, 1880, Austrian.—This is a bolt gun with a revolving cylinder placed in a drum beneath the bolt. This cylinder, in place of holes parallel to the axis, as in revolvers, has grooves in its outer surface, as in the Lowell and other machine guns, and the bolt works through one after another in succession. The cylinder is supplied with cartridges through an opening on the right-hand side, as in the Colt breech-loading revolver. This gun approaches closely to the drum magazine gun of Schulhoff type. The Swingle is similar to the American Roper system of 1866.

268. Franklin's detachable gravity magazine, 1887, bolt gun, caliber .45, loaned by Colt's Patent Firearms Company.—This gun has a sliding and turning bolt. The magazine is attached to the top of the receiver at the side. The cartridges are fed from the magazine by the

action of gravity. When the bolt is closed, one cartridge lies beside it in the receiver, and when the empty shell is withdrawn by the extractor, this cartridge slides down to be pushed into the chamber by the bolt. There are two gates just under the magazine, operated by the bolt, which prevent a second cartridge from dropping into the receiver when the bolt is withdrawn. The magazine is a tin box, nearly square in cross section, with a zigzag partition within. The cartridges, therefore, lie in a folded row side by side in the box, in a more compact form than if placed in a flat box. General Franklin brought before the magazine gun board of 1882 a gun having a tubular magazine above the barrel, the cartridges dropping by gravity into the receiver when the bolt was drawn back. As early as 1869 a detachable gravity magazine was brought out, called by the inventor, J. D. Green, a detachable cartridge pannier. It was in form somewhat similar to the Franklin box magazine. This magazine was placed on a bolt gun at the right side of the receiver, which was slotted through from right to left. To load from the magazine it was necessary to turn the gun on its left side, when the cartridge rolled down into position to be caught by the bolt and pushed forward into the chamber. When the bolt was drawn back and the gun turned again to position for loading, the empty shell, drawn out by an extractor on the bolt, fell out through a slot in the left side of the magazine. Another gravity magazine for small arms was brought out by Bethel Burton in 1880. This may be described as a detachable hopper magazine, consisting of a straight feed case practically like the Franklin feed case of 1875, formerly used for the Gatling gun. This magazine was placed at the side of the receiver, and cartridges fell by gravity into a cavity under the receiver, being then pushed up by a carrier to the level of the bolt. A gravity magazine placed over the breechblock was suggested by Diaz in 1869 and by Quimby in 1877, and a hopper, suggested by White for supplying cartridges to load a revolver, appeared in 1855. Gravity magazines for small arms have found but little favor, and even for machine guns they are being displaced by more direct and positive feed. In the Loewe or Barthelmes magazine the cartridges are fed into the receiver by gravity, although it resembles the modern box magazine in general construction, use of a spring follower, etc. It is detachable, made to envelop the stock under the receiver, and it is fitted with a spring to force the cartridges up to the mouth, but the cartridges are not fed by the spring into the receiver, being made to fall by gravity from a swinging "carrier" at the mouth. This carrier is operated by coming in contact with the handle of the bolt.

269. Sporer magazine gun, caliber .30, 1890.—Adaptation of box to tubular magazines. The magazine for this gun is really a cross between the box magazine and the tubular magazine in the butt stock. There is nothing particularly distinctive in the construction of the sliding and

turning bolt. The cartridges are fed up into the receiver and into the cartridge chamber after the manner of the Hotchkiss magazine gun, through an inclined tube formed under the receiver. An extension of this tube runs to the rear the length of the butt stock. A few inches from the rear end the tube is open at the top about the length of a cartridge, a slot extending through this opening upward through the stock to the top. Cartridges are fed in through this slot in the butt stock. Just in the rear of this slot is a plunger acted on by a spring in the rear, and having a limited forward and back motion in the tube. A downward projection from the bolt engages a sliding rod, which projects to the rear and carries at its end a catch which bears against the plunger, so that retracting the bolt forces the plunger back until this catch is tripped from the head of the plunger, allowing the plunger to move suddenly forward under the action of its spring. A cartridge, which drops down into the tube from the slot, is impelled by the blow from the plunger with sufficient force to reach the front end of the tube, where it is caught by the bolt in its forward motion and forced into the cartridge chamber. The slot, which forms the box part of the magazine, is closed on the top by a lid hinged in rear, the same hinge also carrying a follower lever, which is pressed down by a spring. Opening the lid presses it against a lug at the rear of the follower lever, raising the latter and pressing it flat against the under side of the lid when the lid is brought to a vertical position. Cartridges can then be dropped in, or they can be fed down by engaging the heads of the cartridge cases in grooves on the under side of the lid, after the manner employed with the feed guides of the Gardner and Gatling machine guns. This gun was tested by the United States magazine gun board of 1892. It is quite similar to the Livermore-Russell device brought before the magazine gun board of 1878, and provided with a magazine filler of a form developed more fully in the box magazines described under the head of "Modern magazine guns." A similar device of about the same period is illustrated in the Merriam charger for the Evans magazine. One of the earliest forms of butt-stock magazines containing a large reserve of cartridges is illustrated in Wilson's magazine, 1864.

MODERN MILITARY MAGAZINE GUNS.

These have box magazines placed near the receiver with cartridges touching sidewise instead of end to end. They are either detachable and arranged to be readily replaced, or fixed in place and arranged to be rapidly refilled from compact packing cases, or they are a combination of these two systems. The Lee is the type of the detachable magazine. It has been adopted in modified form by England, as described below. The other type is now coming into prominence from its recent adoption in some form by several nations. One great

advantage of the box magazine is that the bullet of one cartridge does not rest against the primer of another, and so the possibility is removed of exploding a cartridge in the magazine or injuring the bullet by shock from another cartridge. If necessary a spring plate can be placed front or rear to lessen all shock. In some, an opening at the side allows inspection of the interior. They work without carrier block or spoon, though some, like the Rubin, have a catch operated by the bolt to check and release cartridges. The chief advantage, however, is that it enables the supply of cartridges to be rapidly renewed. This becomes more and more apparent with the reduction of caliber and lengthening of the cartridge. While box magazines avoid the slow process of inserting cartridges one at a time end wise, some of these require the refilling to be done through the receiver with the bolt drawn back, thus failing in a point covered in several tubular magazines—the power to refill when the gun is loaded.

The modern box magazine is adapted particularly to the bolt gun, which has become almost universal for military use; but box magazines are applicable like tubular magizines to other forms of breech mechanism. Almost all the various forms of breech bolts are suited to any one of the box magazines described with but very slight modification in the bolt, such as in the position of the extractor, of the handle, etc., not altering its essential character; so that in considering the advantages and disadvantages of a certain magazine, too much stress should not be laid on the bolt which is used with it. The comparison of magazines should be made with similar bolts, or at least with bolts working with equal ease and equally well suited to stand the tests to which magazines are subjected.

The bolt most commonly used is of the old familiar type, similar to a door bolt, sliding forward and back, and locked by turning down the handle, so engaging lugs or screw threads in recesses in the receiver. It has a firing pin running lengthwise through the bolt, operated by a spiral spring concealed, like the firing pin, within the bolt. Bolts of this kind, however, differ in many points of construction, increasing or diminishing the ease of manipulation. For the modern small-caliber rifle using smokeless powder it is considered almost essential that a turning bolt, which is necessarily of small diameter, giving thin walls, should have the supporting lug at the front end, so that the strain of recoil may not be brought upon the long stem of the bolt itself. With some bolts the firing pin is cocked in closing, the pressure of the firing-pin spring being then brought against the hand in pushing the bolt forward, as in the Lee gun. The method generally preferred is one in which the turning of the bolt cams back the firing pin and compresses the spring before the bolt is withdrawn. With this system, turning down the handle to lock the bolt, after closing it, finds the firing pin already drawn back ready to be held by the sear of the trigger.

The Mauser single-loading gun and the Hotchkiss magazine gun illustrate some of the earlier forms of this type. These bolts had a separate piece at the front end carrying the extractor and made so that it would not turn with the handle. The construction now preferred is one in which the whole forward end of the bolt turns with the handle, while the extractor is held from turning. The Lee bolt is one of the earliest of this type.

A number of attempts have been made to substitute a bolt working by a direct forward and back motion, and several examples of these are mentioned below. They have been adopted in few cases, and of those yet tested the main difficulty seems to be that the mechanism does not provide sufficient camming action to readily start the cartridge in beginning to open the bolt. In these arms a sliding handle is made to wedge the bolt around when pushed well forward, the bolt being secured by the usual locking lugs, or the bolt has no turning motion whatever, and the sliding handle operates a turning sleeve or a locking brace to keep the breech closed. In the last form, with the locking brace, it is not so essential to have the support of the bolt at the forward end, since the bolt can be stiffened by longitudinal ribs without enlarging the receiver too much.

Every effort was made to obtain for exhibition all the guns that were tested by the recent magazine gun boards of 1882, 1892, and 1893, and letters were sent to parties interested. Several of these guns were sent for exhibition, but in some cases the inventors refused to send their guns and in some cases failed to reply.

The great heat developed with the new cartridge demands some protection for the hand. This protection is usually obtained by a wooden envelope extending over the whole of the barrel, or over that part which is usually grasped by the hand in firing. The Germans surround the barrel with a metallic case, leaving an air space between it and the barrel.

As an illustration of the rapid development of the box magazine, it may be stated that whereas the first two magazines described below were the only ones of this class brought up for trial before the United States board on magazine guns in 1882, all others being tubular magazines, only three tubular magazines were presented before the board of 1892, all the rest being box magazines.

The first five box magazines described below are types of nearly all the later forms: (1) the Lee, that of the detachable magazines; (2) the Livermore-Russell, that of the fixed magazines filled by pushing in cartridges from a clip or magazine filler, and of the magazines feeding automatically into the receiver from one side; (3) the Tiesing-Kennedy, that of the fixed magazine filled at the bottom and fitted with a lid which, in opening, retracts the cartridge follower; (4) and the Schulhoff, that of magazines made in the form of a drum and fitted

with a revolving cartridge follower. (5) The Mannlicher is the type of those combining the fixed and detachable forms, having the operating parts fixed to the piece in a magazine chamber, while the cartridges are held in a separate holder, which, when inserted with the cartridges, forms temporarily a part of the magazine.

270. Lee magazine rifle, caliber 45, 1879.—The earliest detachable box magazine under the receiver. This is a bolt gun, with an opening the length of a cartridge in the bottom of the receiver, just back of the barrel, and it has a detachable magazine, which is inserted from below. Several of these magazines are carried on a belt. They are each provided with a spring and follower within, to force the cartridge up, and they are filled up in advance by the soldier, as it is intended to have them saved. When a magazine on the gun is emptied, it is dropped out by pressing a spring, and a new one already filled is inserted. A magazine holds five cartridges of our old service model, caliber .45. The gun can be used as a single loader when the magazine is off, as a spring plate then covers the bottom of the receiver. The magazine can be filled when on the gun by drawing back the bolt and inserting the cartridges singly.

The earlier models of the Lee gun had a flat, zigzag spring in the magazine to press the cartridge follower up, but in the later models a flat, curved spring is used, fastened at the top of the front wall of the magazine, running down below the follower and curving up underneath it. The extractor does not turn with the bolt, but the turning part of the bolt extends through to the cartridge. In the early models the handle of the bolt was placed far enough forward to turn down opposite the receiver, just in front of a shoulder on the frame of the receiver, to act as a partial support of the bolt, a lug on the opposite side assisting. In later models the handle is in rear, bent downward and outward to bring the hand close to the trigger when the bolt is closed, the support formerly given by the handle being borne by the end of a longitudinal rib on the bolt, a lug, as before, supporting the strain on the other side. Lee was the first to bring out a practical central box magazine in front of the trigger. (See Report of Chief of Ordnance for 1882; see also the English Lee-Speed gun described below.) The Hampden gun, brought before the United States magazine gun board of 1892, had a detachable magazine similar to the Lee and, like it, fitted with a spring, but it was set with mouth down at the left side of the receiver, the box sticking upward above the barrel. The cartridges fed through an aperture in the side of the receiver.

271. Livermore-Russell magazine gun, caliber .45, 1880.—The magazine is placed at the side, extending downward, an opening at the side of the receiver admitting cartridges from the magazine to the front of the bolt when drawn back; but the special feature is the spring gate at the top, closing an outer mouth. This allows cartridges to be

inserted singly, or to be forced in all together from a packing case, even when the gun is loaded, but prevents their exit there and guides them toward the other opening leading to the receiver. The feed of the magazine can be cut off by a stop, which simply keeps the bolt from drawing back far enough to catch the flange of the cartridge, and the gun can then be used as a single loader.

The position of the magazine allows an opening to be made in the side through which the soldier can see how many cartridges remain in reserve.

The packing case is made of light tin, and the cartridges are held in by flexible lips at the open bottom. When the case is placed over the magazine the cartridges are pushed down by the thumb or finger, passing through the slot in the case, and the lips yield, allowing the cartridges to pass at once to the magazine. These cases are light and cheap, and they require no spring. They can be carried like detachable magazines on the belt, and cartridges can be packed in them at the arsenals for issue to the soldiers.

This is the first known magazine filler for box magazines. Tubular fillers are referred to in description of the Spencer and Winchester magazine guns.

The gun in the exhibit has practically the Mauser or Hotchkiss bolt. (See Report of the Chief of Ordnance for 1882.) This magazine was tested by the magazine gun board of 1882, and brought before that of 1892, but not tested.

272. Tiesing-Kennedy magazine gun, 1880.—The magazine of this gun is placed like the Lee magazine, under the bolt, but it is fixed in place, and its position is a little farther in rear of the barrel than in the Lee, so that the magazine is always partially covered by the bolt. In feeding from the magazine into the receiver, the top cartridge of the magazine is first pushed part way forward by a tongue under the bolt, and left in a bed or pocket just in rear of the barrel, so that the next movement of the bolt shall push the cartridge into the cartridge chamber. The bolt does not differ essentially from that of the German Mauser, model of 1871. The cartridges are inserted into the magazine at the bottom, which is closed by a lid swinging around a horizontal hinge at the front. The follower is a hinged leaf placed on the end of a lever which swings on a pivot at the lower front end of the magazine. Flat springs are used to force the arm and follower up. This style of follower is, in principle, now adopted for most magazine guns. The special peculiarity, however, of the mouth lies in the arrangement for folding back the follower lever when the lid at the mouth of the magazine is opened. This is accomplished by having the lever pivoted to the lid a little in rear of the hinge instead of to the front wall of the magazine. Opening the lid, therefore, draws the pivot of the follower arm down and causes a projection on the front of the

follower arm to strike a stud fixed to the front wall of the magazine, so that when the lid is wide open the arm is flat back against it, leaving the opening of the magazine free for the insertion of cartridges. Closing the lid releases the follower and allows it to press against the cartridges within the magazine.

273. Schulhoff magazine gun, Austrian invention, 1888.—The Schulhoff magazine gun is also an Austrian invention. The magazine is a fixed hollow drum under the receiver. An axial shaft, nearly parallel to the barrel and turned by a spiral around its front end, runs through the drum, and this carries a radial plate which revolves with the shaft and acts as a "follower," pushing before it cartridges placed in the magazine, and delivering them at an opening in the bottom of the receiver, where they can be caught by the bolt in loading. An opening on the right-hand side of the magazine allows cartridges to be inserted, and a lid closes the opening. This lid is hinged at the bottom, and it is opened outward and downward by pressing on a projecting thumb piece. The lid in opening retracts the follower, as in the Tiesing-Kennedy magazine. A toothed projection from the hinge of the lid catches in a cogwheel on the follower shaft, and, opening the lid revolves the follower to a position beyond the entrance. Closing the lid releases the follower and brings the pressure from the spring against the cartridges. The magazine fillers, described above for type gun No. 2, are also used to fill the Schulhoff magazine rapidly, but loose cartridges can be thrown in readily. The curved form of the magazine causes the cartridges to arrange themselves lengthwise as they fall in. This magazine holds 9 of the new small-caliber cartridges. It is not necessary to unload the piece to fill the magazine, but separate motions must be made to open and close the latter. The gun is a natural development from the Swingle revolving gun described above. The cut-off for the magazine is a slide on the side opposite the lid. It is curved to fit the outer surface of the drum, and pushing the handle slips it round so that the end comes over the opening into the receiver. The drum shape gives great capacity to the magazine without affecting the symmetry of the piece. (See Report of the Chief of Ordnance for 1889, describing the tests of this gun, in which the action of the magazine was entirely satisfactory, but the bolt was found to be weak and defective.) The bolt is of the usual sliding and turning pattern, with locking-lugs in rear but not in front. The Schulhoff idea of a drum magazine seems to have been anticipated in America by Andrew Burgess, who devised a similar form in 1887, filling on one side of the gun and feeding around to a mouth on the opposite side of the receiver.

Schulhoff magazine pistol: A pistol is constructed by Schulhoff with a magazine working on the same principle. It has a bolt mechanism, which is operated by the trigger. The trigger is double, and pressure

on the forward part draws out the bolt, ejecting the old shell, and then closes the bolt, pushing in a new cartridge. Further motion of this trigger causes it to strike the second trigger and fire the pistol. Fixed straight box magazines for pistols appear as early as 1873, credited to Rodier and Bates.

274. Mannlicher magazine rifle, Austrian, caliber .315, 1888.—In the Mannlicher gun the bolt is operated by a simple forward and back motion of the hand, avoiding the necessity of turning the bolt to secure it after closing or to unlock it for opening. The handle is a round knob at the rear, connected with a piece which slides in and out at the end of the bolt, and which has a wedge-shaped projection below. Hinged at its front to the underside of the bolt, in rear of the magazine, is a brace, or cam latch, and the wedge above referred to works in a slot in the rear and top of this brace, forcing the latter down when the bolt is pushed well forward, and securing it against a shoulder in the frame of the gun. Drawing back the handle raises the brace by inclined projecting lips on the wedge, and allows the bolt to slip back. This method of locking the bolt by a brace or cam has been adopted in the Colt magazine gun above described. The Mannlicher magazine is under the receiver, and to fill it the bolt is drawn back. A special cartridge feed case or clip is used with this gun. This case holds the flange ends only of the cartridges, and the top one alone can move forward. The whole package, case and all, is inserted from above into the magazine, the spring in the magazine acting through the case on the cartridges. The emptied case either falls out at the bottom of the magazine or it is forced out by inserting another full case. Cartridges can not be inserted one at a time into the magazine, as the case forms part of the mechanism to control the cartridges, making a sort of cross between a detachable and fixed magazine. The cartridge follower is similar to that described for the Tiesing-Kennedy, but the lever is hinged to the front wall of the magazine, and the springs are arranged differently. This gun was tested by the United States magazine-gun board of 1892.

275. Lee-Speed, English, detachable magazine, caliber .303.—The bolt of this gun resembles the Lee bolt in essential particulars, but the extractor is attached to a fixed head which does not revolve with the bolt. A protecting plate covers the bolt, sliding with it but not turning. Like the recent forms of the Lee bolt, the handle is placed in rear, and it is bent downward and curved outward to bring the hand nearer to the trigger when the bolt is closed. The bolt head, which carries the extractor, does not turn with the handle. The magazine is detachable, and it is essentially that of the Lee gun, but it is made like the Schmidt fixed magazine, described below, broad enough to hold two vertical rows of cartridges, the rows overlapping by about half the diameter of a cartridge, so that the cartridges of the two rows

are alternately presented at the top of the magazine in front of the bolt. The follower plate is lower on one side than on the other, to correspond. The follower spring is of wire, wound in an oblong spiral. The sides of the magazine at the top and near the rear have lips curved inward, so that the cartridges are caught alternately on opposite sides and prevented from springing out until pushed forward by the bolt. The magazines of the first model adopted held 8 cartridges, but those of the present model hold 10. When on the gun, the magazine can be filled from clips, but this method is not practiced. One magazine is chained to the gun by a link connecting a staple on the gun to one projecting from the front of the magazine. When this magazine is exhausted it is dropped from its socket and left hanging, while a full one from the belt is inserted in its place. A broad, flat plate, swinging laterally, is attached by a pivot at its front end to the underside of the right-hand bar of the receiver, and the magazine is cut off when this plate is swung in. When the magazine is detached, this plate also acts as a floor to the receiver for single firing.

This gun was tested by the United States magazine-gun board of 1892.

276. Rubin magazine gun, Swiss, 1888, caliber .295.—This has a magazine set like the Lee, under the receiver, but fixed in place. To fill it the bolt is drawn out and cartridges are inserted from above through the receiver. They are put in singly or are all pushed in together from a clip or packing case. A spring gate is placed at the mouth of the magazine, and the motion of this gate is controlled by a bolt to allow cartridges to pass up in succession from the magazine to the position for loading. (See Report of the Chief of Ordnance for 1889.) The bolt used is practically that of the Swiss Vetterlin tubular magazine gun.

277. Schmidt magazine gun, Switzerland, caliber .295.—This gun has been adopted by Switzerland in place of the Vetterlin tubular magazine gun. The magazine is fixed underneath the receiver like the Rubin magazine, and, like the Rubin, it is intended to be filled through the receiver from a clip; but the clip, holding 6 cartridges, is made of pasteboard shod with tin at the bottom, and it has the slot for the finger of the hand extended over the top and part way down on the left side, causing less obstruction to the finger in pushing out the cartridges than when the slot extends only up one side and over the top. The magazine holds 12 cartridges. It consists of a box, which, though not "detachable," is made practically like the English Lee-Speed, with overhanging lips and wire follower spring, the cartridges being arranged in two vertical rows and the follower being lower on ode side than on the other. The space between the lips is wide enough also to allow cartridges to enter unobstructed from the clip, and no spring catch is needed, at the mouth, as in the Rubin gun,

or in the Mauser, next described. It takes two full clips to fill the magazine. Cartridges can be put into the magazine singly if desired. To use the gun as a single loader, the magazine can be lowered by means of a side lever until the top cartridge sinks below the level of the bolt. The bolt works by a direct forward-and-back motion of the hand, as in the Austrian Mannlicher rifle, but the mechanism is different. The handle, projecting from the right side, is attached to a slide extending longitudinally along the bolt and guided by a slot in the side of the housing. The body of the bolt does not turn. It is secured by locking lugs on a turning sleeve, which embraces the body at the rear. The sleeve has a spiral groove in which moves a stud projecting from the inner side of the handle of the slide. The bolt being closed, a pull on the handle turns the sleeve, thereby freeing the two locking lugs, and a continuation of the pull draws the bolt back. Reversing the movement pushes in the bolt and turns it. It is said that some models of the Swiss gun have an attachment for firing the piece automatically when the bolt is closed, without pressing the trigger. This gun was tested by the United States magazine gun board of 1892.

278. Mauser box-magazine gun, caliber .301.—The magazine of this gun is fixed under the receiver as in the Rubin gun, and the magazine is filled, in the same manner as the Rubin, by passing cartridges through the receiver from the loading clip. The special peculiarity lies in the form of this clip. Instead of being a box surrounding the ends of the cartridges, as in the Rubin gun, the Mauser clip is a simple strip of metal with its longer sides doubled over into lips, constituting a slide along which the heads of the cartridges slip, the lips curving over the flanges of the cartridges or fitting into the grooves in the heads of the cartridges where the cannelured head is used. A flat spring placed lengthwise in this holder presses the cartridges forward against the lips, and prevents their being easily deranged. This forms a symmetrical package, so that it may be placed either end up in inserting the cartridges. The sides of the magazine itself are formed of spring steel, having at the top overhanging lips, which allow the cartridges to be pushed past them into the magazine, but which press in with sufficient force to retain the cartridges until they are pushed forward in succession by the bolt. To fill the magazine, the bolt is drawn back, and the clip holding the cartridges is placed in the receiver over the mouth of the magazine, the thumb or finger pushing the cartridges out of the clip and down into the magazine. A spring at the side of the receiver holds the clip lightly in place after use, until the bolt, moving forward, throws it out automatically. There is no marked peculiarity about the follower, which is practically of the Mannlicher pattern, with a hinged leaf at the top of the follower arm forming a floor to the receiver for single loading when no cartridges are in the magazine. This gun has

been adopted in Belgium with a caliber of .301, and no cut-off is used; but in the model exhibited the magazine is arranged to slide up and down in the stock by the action of a short lever at the side, after the manner of the Schmidt. When the magazine is depressed, the piece can be used as a single loader even when full of cartridges, as the bolt passes over the top cartridge in the magazine. Cartridges with cannelured heads are used with the Belgian model. The Mauser guns have the sliding and turning bolt, essentially that of the old Mauser gun (German model 1871), but it has a solid head with two locking lugs in front. The firing pin is inserted from the rear, as in the Lee and Remington-Keene bolts, but the firing-pin spring bears at the rear on a collar which screws into the body of the bolt, the firing pin passing through this collar to the rear. The ejector is pivoted at its rear end on a lug at the left of the breech housing in rear of the receiver. It forms a part of the catch which serves to retain the loading clip in place in loading. In the Belgian model the extractor turns with the bolt; in the other model it does not. The handle is at the rear end of the bolt. This gun was tested by the United States magazine gun board of 1892.

279. Russell swinging magazine, caliber .45.—The only peculiarity in this consists in the arrangement of the magazine, which, though placed centrally under the receiver as in the Lee gun, is not detachable, but is made to swing about horizontal bearings, front and rear, so that the mouth of the magazine can be moved to the right under a spring gate attached to the outer side of the receiver. The gate acts automatically to allow the cartridges to be pushed in without obstruction and to prevent their escape. This allows the cartridges to be inserted into the magazine singly or from a clip, without passing them through the receiver or requiring the bolt to be opened. The ordinary Lee spring and follower are used. When the magazine is full it can be swung back to the vertical position for use, or held to one side for reserve, a projection on the left side of the magazine forming a floor to the receiver for use in single firing. This magazine is attached to the ordinary Lee gun, the breech mechanism serving simply as a type. Brought before the United States magazine gun board of 1892, but not tested.

280. Mannlicher carbine, Austrian, caliber .315.—This uses the same loading clip as above described for the Austrian Mannlicher rifle. The follower differs from that of the rifle by the omission of the hinged leaf at the top, so that there is no floor to the receiver when the cartridges are not in the magazine. For single loading, therefore, cartridges have to be partially or wholly inserted into the firing chamber by hand. In this respect the arm is similar to that adopted for the German army. The bolt of the carbine works like that of the rifle, by a direct forward and back motion of the handle, but the locking mechanism differs. In the carbine the body of the bolt slides and turns. It

has a solid head, with two front locking lugs, the firing pin being inserted from the rear, and the firing pin spring being supported by a collar screwed in at the rear. The body of the bolt has spiral grooves on the exterior, in which move inclined studs on the interior of a sleeve which envelops the rear end of the body of the bolt, and which carries the handle. This sleeve has simply a forward and back motion. When the bolt is closed and the locking lugs are engaged in the locking slots, a pull on the handle moves the sleeve back, turning the bolt and disengaging the locking lugs, then drawing the bolt back. A reverse movement pushes the bolt to the front, and, when it is forward, turns the body of the bolt and engages the locking lugs. The cartridges of the Austrian Mannlicher rifle and carbine have flanged heads, and these flanges are arranged in the clip so that they overlap. Hence the clip has a bottom and a top, and it can be inserted only one way into the magazine. This gun was tested by the United States magazine gun board of 1892.

281. German box magazine, model of 1888, caliber .311.—The magazine used with this rifle is of the Mannlicher type, requiring the clip to be inserted with the cartridges and retained in the magazine until the cartridges are fired, the clip constituting an essential part of the magazine. The cartridges used in this arm, however, have cannelured heads, instead of flanged heads, and the clip is therefore symmetrical in shape, so that it can be inserted either end up into the magazine. The follower is a simple lever, the upper-hinged leaf of the Mannlicher system being abandoned, so that cartridges have to be inserted by hand into the firing chamber of the barrel when the gun is used as a single loader with the magazine empty. There is no provision for cutting off the magazine. The bolt differs but little in material points from the bolt of the old Mauser system, formerly used in the German service with a single-loading gun and with a tubular magazine gun, the main difference being that the body or turning portion of the bolt has two front locking lugs which engage in locking grooves in the frame of the receiver. The head of the bolt, to which the extractor is secured, does not turn. This gun was tested by the United States magazine gun board of 1892.

282. Mannlicher carbine, Roumania, caliber, .256.—This, like the German gun, has a magazine of the Mannlicher type with a sliding and turning bolt. The follower is simply a lever with no swinging leaf, and the magazine has no cut-off. But the cartridges have flanged heads, and the clip for holding them, though similar to that of the Austrian Mannlicher, is so curved at the back that the flanges of the cartridges lie on each other, but do not overlap. This makes the clip symmetrical and it can be inserted either way up, gaining the advantage found in the German clip where cartridges with cannelured heads are used. The general construction of the bolt is similar to the German, with a

movable bolthead; but on the side opposite the extractor is a sliding ejector which is made to slip forward beyond the face of the bolt on striking a bolt catch in rear as the bolt moves backward. This form of ejector was used in the Ward-Burton tubular magazine gun. This gun was tested by the United States magazine gun board of 1892.

283. Berthier, the model adopted in France for the cavalry, the arm exhibited adapted to caliber .30 cartridge.—The clip like that of the Roumanian Mannlicher is symmetrical, flanges of cartridges touching tangentially, but not overlapping. In general mechanism the follower, which consists of a lever and hinged leaf, does not differ materially from the Mannlicher, except that a single spring with two branches serves to work both the lever and the follower. The bolt resembles in general the Hotchkiss, with a turning bolthead, middle handle, and a rib running along the body of the bolt from the handle; but the firing pin is attached to the cocking piece in rear without the use of a screw nut. In place of a screw nut a cylindrical clutch is used with an undercut groove in its face, which slips over side notches cut near the end of the firing pin. The clutch is then prevented from moving by slipping into a recess in the rear of the cocking piece. The clip carries but four cartridges. This gun was tested by the United States magazine gun board of 1892.

284. Bergman rifle.—This gun is the invention of Lieutenant Bergman, of the Swedish army, and it was loaned by the Swedish commissioner for exhibition in the Ordnance Exhibit. This gun presents several novel features. It is a bolt gun, the bolt sliding and turning in the usual manner, but the handle is of peculiar form, curved down and back from the rear end of the bolt so that it forms a grip for the whole hand, and when the breech is closed brings the forefinger naturally in position to pull the trigger. The bolt is solid at the front end except for the perforation for the firing pin, and it has the front locking lugs now commonly used. The firing pin is inserted from the rear as in the general type of the Lee bolt, but arranged so that turning the bolt to unlock and open it draws back the firing pin nearly to the cocking position. The cocking is completed in the forward motion of the bolt as in the Lee, the cocking lug on the firing pin catching the rear of the trigger before the bolt is quite home. The firing-pin spring bears in front against a shoulder on the firing pin and in rear against a sleeve which slips over the end of the firing pin and projects slightly to its rear. The firing pin, with spring and sleeve, is pushed into the bolt from the rear, and a sliding cover is slipped over the rear opening of the bolt, the sleeve on the firing pin sinking into a cavity in the front of this cover and holding it in. The extractor is entirely detached from the bolt. The bar which carries the extractor is simply applied to the side of the bolt, and it works through a groove in the right side of the breech housing. The extractor bar has a pro-

jection on the under side which fits in the groove around the bolt, so that the extractor moves forward and back with the bolt, but does not turn with it. This arrangement allows the housing of the breech to extend wholly over the bolt in rear of the receiver without leaving any opening above. This adds to the strength of the breech and gives a firmer bearing to the bolt. The extractor is fixed to the extractor bar without screws by an undercut pivot. The magazine more nearly resembles the Mauser than any other. It is placed centrally under the receiver, and it evidently can be filled from loading clips, although no clips were provided. To cut off the magazine, it is lowered by means of a lever similar to that used with the Mauser and Schmidt box magazines. Loaned by the Husqvarna Arms Company, Sweden.

285. Mondragon repeating rifle, Mexican, caliber .256.—This gun, invented by Majors Mondragon and Gill of the Mexican artillery, is represented in the exhibit by a drawing contributed by them. This arm is reported to have stood all the tests required by the Mexican authorities. The principal novelty in the magazine, which is of the Mannlicher type, is that the clip is double, carrying the cartridges in two vertical rows like the magazine of the English Lee gun. As the clip is inserted from above through the receiver, this requires the opening in the bottom of the receiver to be unusually wide. The magazine holds 8 cartridges. The bolt appears to be of remarkably simple construction. It is a sliding and turning bolt, operated by a sliding handle, which moves along the right edge of the opening of the receiver. The bolt is a tube of steel, having 6 locking lugs at the forward extremity and 6 others near the middle. On account of the large number of locking lugs, only one-twelfth of a revolution is required to secure the bolt. A stud in the sliding handle works in a helicoidal groove in the outside of the bolt, and transforms the rectilinear motion of the handle into a circular motion for the bolt when the latter is forward, either in opening or closing the mechanism. There seems to be no provision for cutting off the magazine for single loading when the clip is once inserted. For slow firing from the magazine, however, the cartridge fed from the magazine can be replaced after each shot, and so maintain a full magazine for emergencies. An attachment to the mechanism allows great rapidity of fire, in cases where careful aim is not required or where a muzzle rest can be obtained to steady the piece. This consists of a catch which holds the trigger back, so that the piece is fired on closing the bolt without requiring the additional motion of pulling the trigger. In this way, as is claimed, 60 to 80 shots a minute can be fired. In the ordinary magazine firing 40 shots per minute are claimed. The barrel is made of crucible steel, of caliber .256. There are three rifling grooves running a length of 27.56 inches in the barrel, with a twist of 8.66 inches.

286. Livermore-Russell magazine guns, Nos. 2, 3, and 4.—These

three magazines are attached to guns with the Lee-Speed bolt, and their construction illustrates three special features.

Magazine No. 2: This shows the application of a bottom opening, like that of the Tiesing-Kennedy magazine, the type of those filling from below, to a magazine feeding sidewise into the receiver. The lid is dispensed with, and the follower arm, pivoted in front of the magazine, has a thumb piece attached which allows the left hand to depress the lever and so open the magazine without removing the hand from its natural position in holding the gun. This relieves the right hand from the operation of opening and closing a lid and saves time by leaving it free to simply handle the cartridges. The follower, when depressed, swings out only far enough to clear the magazine opening and allow the cartridges to be inserted. Cartridges can be inserted singly or from any ordinary clip.

Magazine No. 3: This magazine shows the use of a clip which can be inserted with the cartridges into the magazine and withdrawn, leaving the cartridges behind. The cartridges when inserted into the magazine are held in by spring lips just below the sides of the receiver. The magazine is central, and the rear of the side walls is cut away at the bottom, while the bottom of the rear wall is slightly narrowed, so that the lower end of the clip is exposed when inserted, allowing the thumb and finger to grasp it and withdraw it downward, leaving the cartridges behind it in the magazine. This clip is not essential in loading, as cartridges can be pushed in singly or from clips of other forms. This magazine has a cut-off.

Magazine No. 4: This shows a method of inserting the clip full of cartridges through a side opening into the space underneath the receiver. A follower lever is hinged in front to the frame of the gun, and it has a lug projecting to the right. In inserting the clip it strikes this lug and depresses the lever, which then holds the cartridges and clip up in place. The lever, working through the clip, forces the cartridges up as the top cartridges are pushed forward successively by the bolt. In this gun the follower lever is hinged on a level with the bottom of the barrel and far enough in front to bear on the lower cartridge, whatever the number of cartridges in the magazine. When the magazine is empty, the end of the follower forms a floor to the receiver for single firing, and no separate hinge or rocking floor is needed. The clip for this magazine holds ten cartridges in two vertical rows.

The three guns above described were tested before the United States magazine gun boards, 1892 and 1893.

287. Bruce magazine gun, caliber .30.—This is peculiar both in bolt mechanism and in the construction of the magazine. The bolt has simply a direct motion forward and back and there is no rotation. It is operated by a handle projecting to the right from a slide extending

along the right side of the bolt, passing through a slot cut in the right side of the frame of the receiver, as in the Schmidt gun. At the rear of the bolt is hinged a brace, which, when the bolt is closed, is pressed down in front of a shoulder in the bottom of the receiver frame, holding the bolt against the pressure of the powder. An incline projection on the top of the brace strikes the overhanging receiver frame as the bolt is nearly home, and forces the brace downward. A tongue projecting from the rear of this hinged piece or brace, and curving slightly downward is encircled by a loop projecting to the left from the rear of the slide, and when the slide is well forward the upper arm of this loop bears upon a shoulder just in front of the tongue and locks the brace down. The breech being closed, a pull on the lever draws back the slide, and the under arm of the loop at the rear end of the slide lifts the brace, by acting on the under curve of the tongue, when a further motion of the handle draws the bolt back. A pin, projecting to the left from near the front end of the slide through a slot in the bolt, engages a sleeve surrounding the front of the firing pin, and the motion of the slide backward in unlocking the bolt also forces back the firing pin slightly, and withdraws its point from beyond the face of the bolt. A reversal of the motion of the handle closes and locks the bolt. The magazine is central and under the receiver, like the Lee. It is not detachable, but it is made to swing downward around a pivot near the bottom of its rear end. When closed it is secured by a spring slide at the lower front end of the magazine, working into catches on the frame. The follower is operated by a system of double levers, and pulling back the securing catch of the magazine, acts on these levers to draw down the follower before the magazine is swung down. It is intended to be filled by use of a peculiar clip, which is also suited for use with the Sporer gun, No. 269. This clip holds only the front ends of the cartridges. It is made of tin, in skeleton form. A front wall with bent edges at the sides is connected by straps at top and bottom with a corrugated loop forming five sockets, through which the cartridges are inserted from the rear, forming a symmetrical package. When the magazine is swung down, this clip, containing the cartridges, is pushed edgewise into the magazine, which has ribs running up the sides of the inner walls to catch the flangs of the cartridges. The clip is then pulled forward lengthwise of the cartridges, the ribs holding the cartridges back in the magazine. The magazine is then swung up for use. To use the piece as a single loader, the magazine can be lowered slightly at the rear to a new bearing on the pivot. This magazine was tested before the magazine gun board of 1892.

288. Blake magazine gun, caliber .30.—The magazine, which is the distinctive feature of this gun, is in exterior appearance similar to the Schulhoff. It is a drum magazine, feeding into the cartridge chamber

through a slot in the bottom of the receiver. It differs, however, entirely from the Schulhoff system in the operation of the magazine and in the method of filling. The drum is merely a shell to hold a detachable cylindrical packet holding seven cartridges, and consisting of a spindle with spring catches which hold the cartridges in position around the axis. When in the drum this spindle is turned by a tongue (similar to that used for turning the cylinder of revolvers), actuated by the rearward movement of the bolt, while in the Schulhoff magazine the cartridges are forced around by a follower actuated by a spiral spring. The lower half of the drum is hinged to the upper half at the left side, so that it can be swung downward, carrying with it the empty spindle, which can then be replaced by a full packet. The drum is then closed for use. In method of loading from the magazine it may fairly be compared to the Swingle gun described above (see No. 267), for the bolt in moving forward pushes the cartridges out of the catches, as in the Swingle it pushes them out of grooves in the cylinder, and the carrier is practically a Swingle cylinder, made detachable and fitted with retaining catches for the cartridges.

This gun was tested before the United States magazine gun boards of 1892 and 1893. Two other drum magazines were tested before these boards, but they could not be obtained for exhibition. These are the Durst and Savage magazines. In general principles of action these two magazines resemble each other and the Schulhoff, in having the cartridges forced around inside the drum and outside of a central spindle, by means of a revolving follower, actuated by a spring; but in both of them the exterior gate used in the Schulhoff gun is omitted and the cartridges are forced into the magazine through the receiver, either singly or by means of cartridge clips. The Durst gun is operated by a sliding and turning bolt, which presents no special novelties of construction. The exterior drum of the Durst gun has just within it an interior drum, which can be rotated slightly back and forth to cover the opening into the receiver and cut off the magazine. The Savage gun has a bolt which is actuated by a lever underneath.

289. Krag-Jorgensen magazine gun, Denmark, caliber .315.—In this gun the magazine feeds into the side of the receiver, as in gun of type No. 2, but the magazine is placed on the left side and it is bent further around, so that it runs under the receiver and extends to the right-hand side of the stock. Here it is closed by a lid, hinged in front like the Tiesing-Kennedy, No. 273, and operating in a similar way to draw back the follower lever, also pivoted to the lid in front, and to fold the follower lever up against the cover, leaving the opening unobstructed for the insertion of cartridges. The spring for the follower plate is omitted and this plate swings freely, so that it folds more closely against the cover than in the Tiesing-Kennedy.

When the gate is open the magazine can be filled by dropping in

cartridges singly, but a clip is also used. The cartridges are held in this clip by a wire catch, which has to be turned by the thumb or finger to allow the cartridges to roll into the magazine.

The bolt combines many of the best features in other turning bolts, the main novelties consisting in the method of attaching the extractor and the construction of the firing pin. The bolt has a solid head with a front locking lug, the firing pin being inserted from the rear as in the Lee form, but, as in the Mauser form, turning the bolt cams back of the firing pin to the cocking position. The special pecularity of the firing pin consists in its having a movable point or striker connected by a ball-and-socket joint with the shank or body, around which the spring is placed. To the rear of the body of the firing pin is riveted a thumb or cocking piece, shaped to form a firm hold for the thumb and fingers. The firing pin, surrounded by its spring, is inserted from the rear, and the spring is held from moving to the rear by a sleeve which surrounds the rear end of the body of the firing pin. This sleeve extends to the rear and upward, where it has an arm projecting forward over the end of the bolt, a groove on the underside of the arm catching over a fillet, which runs partly round the bolt and prevents the sleeve from slipping backward when the bolt is on the gun. The projecting arm of the sleeve is forked to receive the heel of the extractor, which is retained in it by a screw. This screw is liable to work loose in manipulation. With the exception of this screw, the bolt can be dismounted without the use of tools.

The extractor has a long spring shank extending nearly the length of the bolt, and the top of the receiver frame is cut through lengthwise at the rear of the receiver opening to guide the extractor and a longitudinal rib on the bolt.

The handle is placed at the rear of the body of the bolt, and the rear face of the shoulder left on the right side of the receiver frame is curved backward, so that the handle, as the bolt turns, has a camming action, to start the cartridge in beginning to withdraw the bolt. The front face of this shoulder is also curved, so that it serves as a bearing for the rear end of the rib on the bolt and gives the bolt a slow final motion forward as the handle is turned down in closing. The ejector is pivoted in a mortise in the bottom of the receiver a little to the left of the axis. Withdrawal of the bolt causes the front end of the ejector to tilt up, striking the empty shell and throwing it out.

290. Krag-Jörgensen, Norwegian, caliber .256, 1890.—Similar in mechanism to the new United States model, but differing in caliber. This gun was furnished for exhibition by the Krag-Jörgensen Company to illustrate the mechanism of the new magazine gun adopted for the United States service as a result of the tests of the United States magazine-gun boards of 1892 and 1893. The manufacture of the United States gun had not advanced far enough to allow that gun itself to be

exhibited. The form of the stock differs slightly from the United States model and the sights on the gun are different. The bayonet, however, is quite similar to that adopted for the United States service, being a short knife which can be fixed to the muzzle of the gun by a spring catch on the handle of the bayonet. This catch also serves to hold the bayonet in its scabbard when not on the gun.

This gun has been tested by the Norwegian Government, and it is understood to have been adopted. The caliber is .256 instead of the caliber .30 of the United States arm.

The mechanism differs in few points from that of the Danish model before described. The most important modification in the magazine is a change in the position of the hinge for the lid. Instead of having this hinge placed in front, so that the lid swings far out to the front as in the Danish model, the hinge is placed at the lower edge of the mouth, so that the lid swings outward and downward around a horizontal axis as in the Schulhoff magazine above described, the lid when open projecting but little farther than when closed. A lug projects horizontally from the inner face of the lid at the lower edge near the front of the hinge and in rear of the pivot of the follower arm, this pivot being attached to the front wall of the magazine as in the Mauser, German, Berthier, and other guns above described, instead of being attached to the lid as in the Danish model. Opening the lid causes this lug to strike the lever arm and fold it down against the inside of the lid, leaving an opening through which cartridges can be inserted downward and sidewise into the magazine, this arrangement giving the magazine the advantage noted in the curved magazines of the Schulhoff type, that the cartridges can not be inverted in putting them in. The opening which leads from the magazine into the side of the receiver is slightly lower down than in the Danish model, so that the magazine projects less from the left-hand side of the barrel. A great addition to solidity and strength is obtained by forming the front, rear, and bottom walls of the magazine in one piece with the frame of the receiver. As in the Danish model, the left side of the magazine is covered by a curved plate which guides the cartridges to the opening into the receiver. The bolt differs from the Danish model in the absence of a half-cock notch on the cocking piece and in having a safety lock similar to that on the German and other small arms. The cocking piece is screwed to the rear of the firing pin instead of being riveted as in the Danish model. The safety lock attached to the rear of the piece which supports the extractor is operated by a thumb piece which causes a spindle to turn down into a notch in the body of the bolt, locking the firing pin when cocked and preventing motion of the bolt. The ejector differs slightly from the Danish in form and position, but not in principle, and the sear spring is slightly altered. This magazine affords the same facility as the Schulhoff for filling the

magazine with loose cartridges without the use of a filling clip, though the Schulhoff magazine holds more cartridges. A clip, however, can be used with advantage, and from the clip presented for trial with the United States model the cartridges are fed in entirely by gravity. This clip differs from most of the other clips in use in being formed in two parts or two half boxes. The lower part is a flat, open-top box, the side from which the cartridges are to roll out being curved, the other sides flat. Over this fits a flat cover with edges bent down over the three flat sides of the lower box. The two parts completely envelop the cartridges. When the gate is open this clip is applied to the mouth of the magazine, the fingers and thumb grasping the upper and lower parts of the box, and the motion of the fingers slides the cover backward, leaving an open space for the cartridges to escape successively from the clip into the magazine. The clip furnished with the Norwegian model resembles more closely the form described for the Schmidt gun, a box formed of a single piece with a continuous slot running up one side and nearly to the bottom of the other. The retaining catch for the cartridges is different. It is a short hood hinged to the side of the clip near the rear, projecting over the mouth of the clip at the flanged end of the lower cartridge, and formed with a lip projecting from the under surface. In filling the magazine, the lid being first opened, the clip is applied from above and from the rear, with a forward motion, causing the rear wall of the magazine to catch the lip and to push back the retaining hood, so that the cartridges pass naturally into the magazine, assisted by the fingers of the hand.

The United States carbine of this system will be of the same caliber as the rifle and adapted to the same cartridge, the barrel being shortened from 30 to 22 inches, with sights of the same general design as those for the rifle.

AUTOMATIC GUNS AND ELECTRIC GUNS.

It remains to be seen what will result from the use of magazine guns operating by their own recoil, or by utilizing part of the powder pressure. Maxim, the inventor of the automatic recoil machine gun, has also invented a musket acting on a similar principle, in one form practically adopting the system of feeding used in the Swingle revolver gun above described, and in an earlier form using a modification of the Winchester system, operated by a spring butt plate. The Freddi gun here exhibited acts on a principle similar to the Maxim, but it has a box magazine. The Pitcher gun, also exhibited, acts by pressure of gas from the cartridge, and this has a tubular magazine. The peculiar principle of these guns, however, is independent of the style of magazine adopted. No specimen of electric guns could be obtained, but this type was represented by drawings and description. The full possibilities of this arm have not been developed. The great

advantage of such a gun would be the simplification of mechanism by dipensing with the firing pin and its spring. This would materially reduce the force required to operate the bolt.

291. The Freddi automatic recoil gun, invented by Maj. G. Freddi, Italian artillery.—During the fire the force of recoil is utilized to produce automatic loading. At each shot the barrel slides to the rear in the stock, compressing a spring which returns the barrel immediately to its former position, leaving the breech open, the breech bolt being held back by a catch pivoted to a guide plate on the stock. This operation throws out the empty cartridge case, and, at the same time, a new cartridge is automatically brought in front of the bolt from a box magazine fixed in the stock below the forward position of the receiver.

The breech is closed and the loading completed by simply pressing the thumb of the right hand on the catch which holds the bolt back, and so letting the bolt fly forward under the action of another spring also compressed by the recoil. A pull on the trigger discharges the piece. Since the bolt catch can be released without removing the finger from the trigger, all the cartridges of the magazine may be discharged without requiring the removal of the finger from the trigger, and without deranging the aim. The soldier, therefore, releases the breech mechanism while the breech is still open and the cartridge unsupported, the breech being closed by a spring, and the piece fired automatically, as in the single-fire gun devised several years ago by Col. J. M. Whittemore, of the Ordnance Department, to reduce the number of motions in loading. In that gun, pulling the trigger, with the breech open, both closed the breech and fired the cartridge. See the description of the Mondragon box-magazine rifle for automatic firing device to avoid pulling the trigger. The Daudeteau gun has a device similar to that of the Mondragon, to increase the rapidity of fire. As the principal recoil in the Freddi gun occurs in the direction of the axis of the bore, and as the springs relieve the shoulder from shock, there is less tendency than in other arms to throw up the muzzle of the piece and so derange the aim. The advantage is obvious. The gun exhibited is of caliber .30 inch, with a magazine containing five cartridges. The initial velocity claimed for the bullet is 2,340 feet per second. The similarity in principle to the Maxim machine gun is noticeable. The breech is closed by a bolt, which moves forward and back in the receiver attached to the rear of the barrel. The bolt has a longitudinal rib at the bottom to prevent its turning. Near the rear of the bolt is a turning sleeve, quite similar to that on the Schmidt rifle, this sleeve carrying three locking lugs, and having two flat spiral surfaces on which work flat projections from the inner surface of an enveloping ring. This ring has only a forward and back motion, and this causes the sleeve to turn, when the bolt is forward, and engage the locking lugs in locking grooves in the frame of the

receiver, made continuous over the bolt in rear. The ring carries handles by which the bolt can be moved by hand, and is kept from turning by a projection underneath, which runs in a longitudinal groove in the plate on the stock. The spring which operates the bolt is attached to this handle ring and to the plate on the stock. The bolt has a solid head pierced for the point of the firing pin, which is introduced into the bolt from the rear, the rear of the firing-pin spring bearing on a sleeve attached to the bolt. The magazine is filled by pushing cartridges into it from a clip; but the clip has some novelties of construction. It is a skeleton clip formed of front and rear walls connected at the sides by wire bent so as to form openings running nearly down the sides, so that the finger can pass nearly through without obstruction. These sides are so formed that the clip is symmetrical, and the cartridges can be pushed out with the clip placed either way up. Tne magazine is filled through the receiver, when the barrel is forward and the breech is open. A similar clip was used with the Durst magazine gun. The weight of the piece is about 8 pounds; but it may be reduced to 5 or 6 pounds by making some of the secondary parts of aluminum instead of iron.

292. Pitcher automatic repeating rifle, 1889–90.—This has a tubular magazine above the barrel, but the special peculiarity lies in the automatic action and, like the last gun described, it is adapted to the box magazine as well as to the tubular magazine. A gun with the tubular magazine above the barrel—General Franklin's—was brought before the United States magazine gun board of 1882, but, unlike this gun, it depended upon gravity for bringing the cartridge down from the magazine. It was a simple bolt gun. The Pitcher gun utilizes a part of the gas from the explosion of the powder, a small aperture in the wall of the barrel just in front of the cartridge admitting the gas into a cylinder below the barrel. Here it acts on a plunger working in the cylinder and drives the plunger forward, compressing a strong spring in front of it. This plunger has a spring rod attached to it, extending backward under the cylinder, and the end of this rod, when the plunger is thrown forward, catches in a sliding bar, which is connected by means of a link and brace with the sliding breech bolt in a manner somewhat similar to the Burgess action. When the force of the gas is expended by the passage of the bullet from the bore, the front spring, acting through the spring rod, forces back the slide and opens the breechblock, the slide moving against and compressing a weaker spring in rear in the butt stock. When the breech is well open, the spring rod is "tripped" from the slide, which is then free to move forward under the action of the rear spring, closing and locking the bolt and at the same time pushing in a fresh cartridge from the magazine above. An inverted spoon carrier, rocking on a bearing in rear, brings down the cartridge from the magazine, to be caught

by the bolt and forced forward. By a continuous pull of the trigger all the shots in the magazine can be fired automatically. For inserting the first cartridge the slide is worked with the hand by means of a handle projecting at the side. A stopcock is provided in the passage leading from the barrel to the cylinder, so that the automatic action can be cut off and the gun operated by hand. The Paulson rifle, recently tried in France, also illustrates this principle of utilizing the escape of gas from the barrel. In principle this gun somewhat resembles the Mallen gun, 1888, adapted to a box magazine wrapped around the stock at the receiver. As early as 1877 the Gardner device for revolvers was brought forward, having the chambers of the revolving cylinder communicate by apertures just in front of the shell, so that the explosion of one cartridge would eject the empty shell in the next chamber, the aperture into the loaded chamber being sealed by the bullet.

293. Pieper electric gun.—This requires no hammer or firing pin. A metal rod, insulated, runs to the rear from the central point of the bottom of the bore. To the butt plate is attached another metal rod, also insulated, running forward in a hole bored in the butt stock and so arranged that, by means of a trigger, its front end can be brought in contact with the first insulated rod. The cartridge has a metallic case, and in place of the percussion cap in the center of the base, an insulated plug of copper is used, running forward in the case nearly to the bullet, and having on its front end a disk of tin foil reaching nearly to the side of the case. A small storage battery is carried in the pocket or in the butt, with the two wires running one to the insulated rod at the butt plate and one to the barrel. When the trigger is pressed, the cartridge being in, electric contact is made at the trigger, and a spark darts from the tin foil to the cartridge case, igniting the powder.

MACHINERY USED IN THE MANUFACTURE OF RIFLE CARTRIDGES CALIBER .45.

This comprises a set of machines and operatives transferred for this purpose from the Frankford Arsenal, Philadelphia. By reason of lack of space a complete set of machines is not shown. On account of the danger the operation of loading these shells is omitted, but a loading machine is shown which is run at pleasure with flaxseed instead of powder. Frankford Arsenal, in the northeastern portion of the city of Philadelphia, is the seat of the manufacture of metallic ammunition for the Army, and of many other special branches connected with the military supply.

The center-fire metallic case cartridge.—(See Ordnance memoranda No. 8, revised.) The successful invention of the self-primed metallic case cartridge has greatly simplified the construction of breech-loading

small arms. Prior to its introduction and use, attempts to prevent the escape of flame through the joint of the breech mechanism were made with, at best, unsatisfactory results. The metallic cartridge overcomes this difficulty, being itself a perfect gas check renewed at every round, prevents foulness and wear of the mechanism, and exercises the most vital functions in the life of the arm. So important an element is it that it may be said that with a perfect cartridge the most indifferent breech arrangement can be used with safety and efficiency. Its advantages, other than that already indicated, are many; its completeness and simplicity being self-primed and used as a whole in loading; its strength and safety, notwithstanding the roughest usage and thorough protection of the powder and fulminate; its accuracy, because of the coincidence of the axis of the bore and bullet, and, added to these, the absolute impossibility of using more than one cartridge at a time. The United States regulation center-fire reloading metallic cartridge consists of the following parts, viz: The tinned-brass case the cap or primer containing two-tenths grain of percussion composition, 70 grains of small-arms powder, and a lubricated lead bullet weighing 500 grains, 16 parts lead, 1 part tin. The case is the tube which forms the receptacle for the powder charge, the percussion composition, and the leaden bullet. Its exterior conformation is designed to facilitate its ready extraction from the chamber of the gun after firing. Besides the rim at the closed end, which is intended primarily to assist extraction, the case is tapered from the rear to a point where it seizes the bullet, whence it merges into a right cylinder. It has a solid flange at the head and a recess in the head for receiving the primer; a perforation at the bottom of the recess to admit the flame to the powder. The case for the .30 caliber cartridge is bottle shaped.

The primer is a small metallic cap, thin enough to yield to the blow of the hammer, but strong enough to prevent perforation by the blow or by the explosion of the powder. The primer, when charged with the composition, is placed within the recess in the base of the shell or case and pressed snugly in, the side of the primer forming a gas check against the walls of the recess, acting as the shell does in the gun.

The bullet enters more than half its length into the case, in order that the lubricant in its grooves may be entirely covered and protected.

To render the cartridge waterproof, a drop of varnish is placed upon each primer after it has been pressed home, and the end of the case is crimped hard against the bullet.

DOUBLE-ACTION PRESS.

The first operation in drawing the tubes is performed by a double-action press. The strips of metal are passed between two wooden rollers covered with cloth saturated with oil, and thence through to a

press having two punches, each 1".1 in diameter, so set that the second punch is to the left and rear of the first, and within each of these punches there is another, 0.6 of an inch in diameter. The exterior punch descending cuts out a flat disk by passing through the metal. This punch then stops, and the disk being over a die, the interior punch continuing to descend, forces the disk through the die, thereby forming a cup about 0.3 of an inch deep and 0.789 of an inch in diameter. After passing through the die the pressure is released, and the cup by expanding slightly frees itself from the punch, which rises to its previous position. As stated, two disks are cut and two cups are formed at each descent of the punches, the press forming cups at the rate of 75 per minute.

SINGLE-ACTION PRESSES.

In order to draw the cups to the dimensions required, they are subjected to the action of six additional punches and dies of decreasing sizes, so as to gradually elongate the cups while reducing their diameter. These draws are made by single-action presses, each having a single punch.

These presses are fed at the rate of 65 tubes per minute by placing them upright on a revolving horizontal plate provided with guides and stops.

In all the presses except the sixth a double die is used to prevent buckling, uneven drawing, and to divide the work, the upper die closing on the metal and the lower one doing the work of drawing.

ANNEALING.

After each draw on the single-action presses, up to and including the fourth, the tubes are annealed in order to restore their ductility. They are heated in revolving cylinders of boiler iron to a peculiar reddish color, when they are thrown into a bath of 1 part of vitriol to 40 parts of water. This removes the oxide scale formed by the heating and restores the original brightness of the metal. They are then placed in a vat of clear water, where they remain until required for the next draw press, before which they are thoroughly rinsed in clear water and sprinkled with oil.

TRIMMING.

After the sixth draw the tubes, being of greater length than necessary, are placed in a trimming machine, where they are pushed onto a rapidly revolving mandrel and brought against a circular cutter, which takes off the surplus metal.

WASHING.

The tubes are now subjected to a thorough washing in a solution of soap and carbonate of soda, which removes all traces of grease. They

are then rinsed in water till clear of the solution and placed in a dry room for at least twelve hours. This precedes the heading, as any oil left in the tube causes it to split in the heading operation.

HEADING MACHINE.

The head or rim of the cartridge case is formed by the heading machine. This machine consists of a horizontal die countersunk at one end for shaping the head, a feed punch to insert the tubes into the die, and a heading punch to flatten the closed end of the tubes into the countersink. The tubes, which are a little longer than the headed case, are fed into the inclined trough of the heading machine, whence they are taken up on the feed punch.

A shoulder on this punch, at a distance from its extremity equal to the inner depth of the headed case, prevents it from extending to the full depth of the tube, and a surplus of metal is thereby left at the closed end of the tube for the formation of the head. The feed punch inserts the tube into the die and holds it there, while the heading punch moves forward by a powerful cam and presses the unsupported projecting portion of the tube into the countersink of the die, forming and accurately shaping the solid head or rim. The headed case, being left in the die as the feed punch recedes, is pushed out by the succeeding tube and thrown by a flipper into the receptacle below. No oil is used in this operation, the moisture of the tubes from the recent washing sufficing as a lubricant. The machine is fed at the rate of 65 per minute. The cases are now finished; but, to be certain that the oil is entirely removed from them, they are again washed in alkaline solution and dried thoroughly in a drying room at a temperature of about 125° F.

TINNING.

The galvanic action induced by the action of sulphur in the powder, or the acid therefrom upon the metal, copper, and zinc of the alloy (brass) not only destroys the property of the powder but likewise deteriorates the case. This action is also induced on the exterior of the case by salt water. To overcome this difficulty the cases are tinned. This operation is commenced by immersing the shells in a vinegar bath to brighten them and clean off all scales, etc.; they are then rinsed in clear cold water and placed in a perforated copper cylinder in alternate layers of pure block tin and cases; the cylinders are placed in a copper boiler lined with tin and filled with a solution of one ounce of bitartrate of potassium in crystals to 1 gallon of water. This is kept hot by means of steam coils for about six hours.

THE PRIMER.

The primer cup is cut from a strip of flat copper ribbon purchased in coils, which are suspended in lubricating wells and drawn by rollers

under a double-action press which punches out and draws the cup as in the first operation on the case. They are washed to remove the oil, rolled in sawdust, and tinned in the same manner as the case.

The tinning of the primer is not essential when the priming is embedded in varnish (as is usual), to prevent galvanic action inducing chemical reaction and destruction of the priming composition; the tin-foil cover of the priming, together with the varnish, excludes moisture, which is essential for chemical reaction, even in the presence of active agents and susceptible metals. The tinning of the primer is therefore entirely for the sake of appearances, in matching the case.

After the cups have received their coating of tin, and have been inspected, they are shaken into a plate holder, and a drop of varnish (shellac dissolved in alcohol) is deposited on the bottom of each; they are then dried before receiving the priming charge.

The varnishing operation is performed by means of a plate supplied with pins corresponding to the perforations of the cup holder; the pins are lowered into a well of varnish, raised, the cup holder inserted, and the pins lowered into the cup.

The cup is now ready to receive the moist composition of priming, which is rubbed into the perforations of a second plate, which latter is placed over the first, and, by a system of pins, the composition is forced into the cups. The cup holders are led under the action of the foiling machine, while a strip of tin foil, varnished on the under side, is drawn across and at right angles to it. A system of punches cut out the disks of tin foil and press them, varnish side downward, over and around the pellets; the punches are hollow on the point, and press the edges down, leaving the center over the pellets raised.

The primers, in this condition, are placed in the drying room, heated by steam pipes, for six weeks, to dry the priming, and which, being hermetically sealed, takes a long time to rid of moisture. After drying, 100 out of 10,000 are tested and if found satisfactory the primers are ready for the anvil.

The anvil is made from a grooved copper wire, purchased in coils, which are suspended in wells of lubricating oil and drawn under a punch which cuts out the anvil. The punch has a slight projection in the center and reduces on each side the diameter of the anvil along the groove, to admit of the passage of the flame. The anvils are shaken into a plate holder and the cup holder is inverted and placed so as to bring the cups over the anvils. By a system of punches the mouth of the cup is engaged over the anvil, the tin plate inverted, and the anvil forced home.

The priming composition consists of fulminate of mercury, by weight, 64 per cent; chlorate of potassium, by weight, 18 per cent; ground-glass crystals, by weight, 18 per cent; gum arabic, gum tragacanth, to mix.

These are mixed together without danger by using the fulminate in a moist state. The various ingredients of this composition possess the following properties:

The fulminate is extremely sensitive to blows, the chlorate moderates the action of the fulminate and increases the temperature of the flame. The glass increases, by friction of the particles, the sensitiveness of the composition, and the gums give cohesion to the mixture.

THE BULLET, CALIBER .45.

The United States elongated service bullets are made of compressed lead. They are more uniform in size and weight, smoother, more homogeneous, and more accurate than cast and swaged bullets, giving better results. The lead for bullets should be pure soft lead of commerce, of specific gravity about 11.35, which is increased by pressure to about 11.45, and which melts at 600° F. and volatilizes at red heat. The lead is first melted and cast in iron molds into cylindrical bars; these bars are passed through rolls which reduce them in diameter. A man and boy will roll and trim in a day of ten hours 3,000 bars of lead.

The bars are fed to the bullet machine through a vertical tube above a horizontal cutter, which cuts at each stroke a length sufficient to form a single bullet, and transfers it to the die, in which, by means of a vertical punch, the bullet is formed with its grooves. The surplus lead is forced out at the junction of the dies in the direction of the longer axis of the bullet, and at the junction of the punch and dies at its head. A bullet machine will make in a day of ten hours 30,000 bullets.

LOADING MACHINE.

The cases are now loaded with powder and bullet by means of the loading machine, which consists of a revolving circular plate with holes or receivers, and a hopper and powder measure. The cases and bullets are fed on revolving plates, 35 a minute; the former are lifted into the receivers, passed under the hopper and measure for a charge of powder, and then under the bullet feeder for a lubricated bullet.

In order to insure a full charge in each cartridge, the machine is provided with a bell which gives notice to the operative of any failure in this particular. The edge of the case is then crimped on the bullet in a very simple manner. The receivers are smaller at the top where the bullet enters than at the bottom where the case is received, the diameter of the former being only equal to that of the interior of the open end of the latter.

After the bullet has been pressed into the case, the cartridge is lifted so that the edge of the case is forced into the conical surface of the receiver between its larger and smaller diameters. The powder is placed in a pasteboard hopper about two feet above the machine, and

is fed to the cases through a paper tube one inch in diameter; the hopper and tube stand inside of a large conical shield of boiler iron.

The loading machine is run upon application by visitors, flaxseed being used instead of powder. After loading, the cartridges are wiped clean and put up in paper packages and packed in wooden boxes for storage.

BLANK CARTRIDGES.

The blank cartridge consists of the brass case and 67 grains of small-arms powder. The case is made in the same manner as for the ball cartridge, except that it receives one more annealing so as to soften the metal and allow of the greater crimp necessary. The case enters the chamber more readily when crimped, and acts at its mouth as a gas check. The powder is pressed firmly in the case and over this is placed a paper cup; the open end of the case is then crimped down and the paper cup varnished.

AMMUNITION.

This includes projectiles for cannon, fuses, primers, powder, and small-arm ammunition. Many projectiles have been described under cannon. Illustration is given below of some of the cartridges and projectiles for our large breech-loading guns; also of the electric welded projectiles shown in the exhibit.

PROJECTILES FOR CANNON.

294. Frankford Arsenal shrapnel for 3.2-inch breech-loading rifle.— The shrapnel, exclusive of filling, consists of head, body, and base. The head is made of cast iron, machined on the exterior, and has a screw thread cut around its base, fitting into the forward part of the body. It is bored and threaded to receive the Frankford Arsenal combination fuse. The head contains the powder chamber, its inner surface being lacquered to prevent premature ignition from friction.

The body is made of lap-welded wrought-iron or low-steel tubing, machined on the exterior and interior to dimensions, and is threaded front and rear to receive the head and base. It is weakened for fracture by circular and longitudinal grooves cut on the inside. It contains a charge of 162 balls, made from an alloy of lead and antimony. These are assembled in the case in circular layers, and held symmetrically in position by cast-iron separators, so-called.

The separators are intended to prevent excessive lodgment or deformation of the balls under the shock of discharge, and increase the effect of explosion by furnishing additional fragments of effective weight. The separators at the end are arranged to prevent independent rotation of the charge of balls. A separator flat on the upper side is placed on top of the charge of balls, and against it the head is screwed.

The base is of cast iron, threaded to screw into the cylindrical case. It is so made as to form a support to the copper band, to prevent deformation of the case at this point from the shock of discharge. The band is of copper, shrunk on its seat and forced into place by running through a die. The seat is roughened to prevent slipping of the band. The total weight of the shrapnel exclusive of fuse is 12 pounds 6½ ounces. The total number of balls and individual pieces in the shrapnel, complete, is 201.

295. Hotchkiss shrapnel for 3.2-inch breech-loading rifle.—The form of the Hotchkiss shrapnel for 3.2-inch breech-loading rifle is illustrated in the figure. The bursting charge is placed in the head of the projectile, and the balls are packed between fragile cast-iron separators. The electric-welded shrapnel for 3.2-inch gun is described under electic-welded projectiles.

296. Projectiles and cartridges shown with cannon.—Projectiles: 12-inch breech-loading rifle, solid shot; 12-inch breech-loading rifled mortar shell, 630 pounds; 12-inch breech-loading rifled mortar shell, 800 pounds; 12-inch breech-loading rifled mortar shell, fired and recovered; 10-inch breech-loading rifle-cored shot; 8-inch breech-loading rifle-cored shot; 7-inch breech-loading rifled howitzer shell; 5-inch breech-loading shell; 3.6-inch breech-loading rifle shell; 3.6-inch breech-loading rifle shell, fired and recovered; 3.6-inch breech-loading rifle shell for point fuse; 3.2-inch breech-loading rifle shell; 3.2-inch breech-loading rifle shell for point fuse; 6-pounder Driggs-Schroeder armor-piercing shell; 6-pounder Seabury common shell; 3.6-inch shrapnel with fuse; 3.2-inch shrapnel with fuse, section; Maxim-Nordenfeldt 6-pounder with fuse, section. Cartridges for cannon: Charges for 3-inch muzzle-loading rifle; charges for 3.2-inch breech-loading rifle; charges for 3.6-inch breech-loading rifle; charges for 3.6-inch breech-loading mortar; charges for 5-inch breech-loading rifle; charges for 7-inch breech-loading howitzer; charges for 8-inch breech-loading rifle; charges for 10-inch breech-loading rifle; charges for 12-inch breech-loading rifle; charges for 12-inch breech-loading mortar, steel; charges for 12-inch breech-loading mortar, cast-iron hooped; charges for 7-inch Ames rifle; charges for 8-inch muzzle-loading converted rifle; charges for 11-inch muzzle-loading converted rifle; charges for 15-inch muzzle-loading smooth bore.

297. Electric-welded projectiles.—(Loaned by the American Projectile Company.) A number of samples of electric-welded projectiles, the invention of Lieut. W. M. Wood, United States Navy, furnished by the American Projectile Company, of Lynn, Mass., are exhibited as follows:

Twelve black enameled 4-inch steel common shell, navy; 4-inch steel common shell, navy; 4-inch steel common shell, with section removed to show interior, navy; 4-inch steel common shell for carry-

ing high explosives, navy; 4-inch shrapnel, navy; piece of 4-inch tubing from which 4-inch common shell are made, navy; 3.2-inch shrapnel, army; 3.2-inch shrapnel, with section removed to show interior, army; 3.2-inch shrapnel fired, uninjured, army; 57 millimeters (6-pounder), army; 57 millimeters, with section removed to show interior, army; 57 millimeters, rough, before finishing, army; 6-inch steel common shell, with section removed to show interior, navy; piece of 6-inch tubing from which 6-inch shell are made, navy; section of 6-inch tubing from which 6-inch shrapnel are made, navy. In making the shell, hollow steel blooms are cast, and from them is rolled out a thick-walled tube, having the approximate finished dimensions of the body of the shell. This is then cut into suitable lengths, and to the short blanks thus made are joined, by electric welding, the head and base of the projectile, which have been previously formed in suitable dies. After this is done the only machining necessary is turning to gauge on the outside, cutting the rotating band score, and the fuse thread and seat. This projectile is afterwards hardened, and thus is produced in this very cheap manner a thoroughly efficient wrought-steel shell. The figures show in order from left to right the principles of formation of the shell, and of the armor-piercing shell made in only two pieces, a section of the armor-piercing shell, and a view of one that has been fired through a 4-inch armor plate. In the welding operation it is only necessary to place the three pieces shown in the left-hand figure in contact, one above the other, in an electric welding machine designed for the purpose, and by means of the electric current, which is passed from one pole to the other through the joint which is to be made, the metal at this point is quickly heated to a welding heat, and being kept in close contact by mechanical pressure, so unites at this point as to become homogeneous and equally strong with the rest of the metal. The surplus metal or burr formed by the pressure is mainly forced upward, and is removed in the operation of truing the body of the shell. For the operation of welding, a large current of low potential is required. It is feasible to weld the highest carbon steels, steels that are absolutely unweldable by any other process, one to another, or to weld a high carbon to a low grade steel, or even to wrought iron. It is seen that the head of a projectile may be made of high-grade expensive steel, and as much of the balance as desired of cheaper, softer material. Another style of projectile now being manufactured is the shrapnel, for the army 3.2-inch fieldpiece. This has a point fuse, but the powder chamber is placed in the base, covered by a steel diaphragm perforated in the center, and having a central tube extending forward to the fuse. The exterior is formed from three parts—the head forging, the tubular section in the middle, and the cup-shaped base forging in which the powder charge rests. The latter has a shoulder on which the dia-

phragm rests, and the copper rotating band is placed on this part of the projectile. The method of making this shrapnel is as follows: The base piece and middle section are placed in contact in the welding machine and joined together, forming a deep cup; while the weld is still hot the diaphragm and tube are dropped into it so that the former rests on the shoulder of the powder chamber. The weld is then lightly swaged, thus locating the diaphragm firmly in place. Next the head forging is placed in contact with the open end of the middle section, with the small central tube passing into the fuse hole, and these parts are then similarly joined by an electric weld. Afterwards the upper end of the small tube is crimped over a slight shoulder in the bottom of the fuse hole. The outside of the shrapnel is then turned to guage. A small hole is drilled in the head, communicating with the interior cavity; through this the shrapnel is filled with the necessary bullets; next the matrix is poured in, and finally the hole is closed by a small plug, which is screwed into place. Before the case is filled with the bullets and matrix it is hardened, to give increased rigidity to the thin walls and to increase the number of fragments into which the case will burst.

298. Zalinski shell for pneumatic dynamite gun.—Eight-inch projectile; 15-inch projectile.

299. Collection of projectiles of old or curious form.

French shell from battlefield of Solferino, lead studs.
Sigourney shell, American, flanged.
Sawyer fired shell, flanged.
Wheat's shell, copper, flanged.
Whitworth's blind shell.
Whitworth's long shell.
Confederate Armstrong shell captured at Fort Fisher.
Blakely Confederate shell, 8-inch, from Fort Fisher, N. C.
Confederate shell, copper band on base, flanged.
Confederate shell, lead band on base, flanged.
Laidley's shell.
Henry shot, copper band.
Allen shot.
Reed's shell.
Dimick shell, fired.
Fifteen-inch steel spherical shot fired against wrought-iron target at Sandy Hook, N. J.
Gorgas shot.
Lawson shot.
Jones shot.
James canister.
Hotchkiss shot, fired.
Hotchkiss canister.
Absterdam shell.
Parrott shell, iron cup.
Parrott shell, fired, brass band, shell cut.
Hotchkiss shell, brass cup in section.
Schenkl shell.
Confederate wrought-iron shot.
Confederate shell, brass and wood base, dowelled.
Confederate shot, corrugated brass band at base.
Confederate shell, two copper bands.
Confederate shell, copper cup with long wood sabot at base.
Confederate shot, lead band, wood base.
Abbot's blind shell, iron and lead, disk on base.
Confederate shot, lead and wood bands.
Confederate shell, lead.
Small cannon balls found at Fort Montgomery in 1871; revolutionary.
Hammered copper balls, Mexican.
Confederate shell cut on section, lead base.
Butler shrapnel cut; one section.
Butler cored shot cut; one section.

Arrick cored shot.
Dana cored shot.
Brass ring for 8-inch Butler shot, fired.
Brass ring for 8-inch Arrick shot, fired.
Brass ring for 8-inch Dana shot, fired.
Krupp breech-loading field shell, body covered with lead.
Breech-loading shot, fired, copper-wire bands.
Patterson breech-loading shot, leather band.
Lindner's breech-loading shot, lead bands with webbing between.
Confederate breech-loading shot, rope band.
Mann's breech-loading shot.
Stafford's steel-faced shot, copper base.
Stafford's steel-faced shot, iron band around air cavities.
12-inch steel shot.
Confederate case shot; ratchet sabot with iron washers; copper fuse plug with leather washers, and tin tube soldered to plug for bursting.
Confederate shot, 4 pounder; wire band, lead bound.
Ritner and Day lead shot, fired through 4½-inch wrought-iron plate.
Confederate shot pierced all over with holes.
Confederate shrapnel case shot cut.
Confederate percussion shell incased.
Stafford's shell, brass band or wheel in front, brass cup at base.
12-pounder spherical case glass shot.
12-pounder elongated glass shot.
Ketchum hand grenade.
United States Dyer shell, lead sabot, 11-pounder.
6-pounder United States Hotchkiss shell, compressed lead band.
Brooke's Confederate shell, 7-inch.
20-inch shell for Rodman gun, with sabot.
Chain shot with cavity for chain.
Chain shot in four parts held by ring.
Chain shot with two shot attached.
Chain shot and case.
McIntyre's repeating shell for rifle, fired.
Puffer's incendiary shell.
Flemming's incendiary shell.
Cochran's diagonal flanged shot, two lead bands around base.
Abbot's elongated shell for smoothbores.
Old pattern carcass.
12-pounder quilted grapeshot.
Bag of cut links.
10-inch wooden shell for pyrotechny.
10-inch paper shell for pyrotechny.
War rocket.
Parachute rocket.
10-inch light ball.
Junk wad.
Hay wad.
Grommet wad.
Experimental diagonal flanged shot, iron and wood sabot.
10-inch Confederate wrought-iron projectile for smoothbores.
Confederate Maury projectile for smoothbore guns, chilled iron, air passage through center.
Confederate cast-iron shot for smoothbore guns, weight 25 pounds.
Confederate winged shot from battlefield of Tennessee.
Experimental shot, diagonal flanges.
Smith's flanged shot, fired at West Point, N. Y.
Wooden flanged shot.
Huginin shell, fired at West Point, N. Y.; wood sabot.
Turbine shot, air passage through center.
Confederate shot, wire through center.
Stand of grapeshot, 12-pounder.
6-pounder canister, model unknown.
6-pounder spherical case shot and sabot.
12-pounder gun shell and sabot.
8-inch English spherical case shot and sabot.
English Boxer projectile and sabot.
24-pounder carcass.

FUSES FOR SHELL AND SHRAPNEL.

The older fuses are arranged on four boards. They embrace most of those that were used during the war of the rebellion.

300. Simple time fuses in wood, metal, and paper cases.—These require the passage of flame over the outer end of the fuse to produce

ignition. They are of wood, metal, or paper. In the wooden fuse the burning composition is driven into a cylindrical hole bored in a conical plug, which can be cut off to allow the desired length of burning. The specimens shown are for the 6 and 12 pounder guns, 8-inch, 12-inch, and 13-inch mortar. In the metal fuse the composition is packed in an annular slot in a thick metal disk screw plug. The specimens shown are the Austrian, Babbitt, Laidley-Bormann, and the Wright. The paper fuse consists of a conical paper case, formed by rolling a triangular strip of stout paper around a cylindrical former, which when withdrawn leaves a cylindrical bore into which the fuse composition is driven. Some of the above fuses have a priming of powder and quick match to facilitate ignition. The specimens of United States paper fuses shown are for 4, 5, 8, 10, 12, 15, 20, 25, 30, 35, and 40 seconds, with two of Rebel make of 5 and 15 seconds. The paper fuses have to be inserted in fuse plugs, hollow plugs of woods or metal driven or screwed into the fuse hole of the shell. The wooden fuse plugs shown are for 6 and 12 pounder guns, 4½-inch siege rifle, 13-inch mortar, 3-inch rifle, 10-inch seacoast gun, and 8-inch seacoast mortar. The metal plugs are of Dyer, Hotchkiss, and Parrott patterns.

301. Special time fuses and fuse plugs.—These are fitted with special features, such as hoods to direct flame to the fuse, water caps to protect open fuses from contact with water in burning, holes in fuse plugs to allow boring into paper fuse without removal, and igniters by which the shock of discharge sets fire to the time fuse without passage of flame over the projectile. The igniters are the most important. The following are the characteristic igniters, others differ ing rather in mechanical arrangement than in principle.

Laidley's igniter consists of a small brass tube, closed at one end, filled with friction powder, in which is embedded a roughened wire projecting at the open end and there weighted with lead. Two igniters are placed open end first in small holes bored in the front of the plug by the side of the time fuse hole, then, on the sudden forward motion of the shell at time of discharge, the lead weights hang back, drawing out the wires and igniting the friction powder. The fire is communicated to the time fuse through small holes near the closed end of igniter tube.

Stevens's igniter has a plunger, suspended by a loop, in the front end. On firing, the plunger hangs back, breaks the loop, and strikes a percussion composition in rear, igniting the time fuse. To the Stevens class belongs the Russian fuse, described on page 836, War Department report on the Centennial Exposition of 1876, the plunger being held in front by an axial wire, which is twisted and pulled apart by the discharge.

Armstrong's igniter contains a sphere of percussion composition which is crushed by the discharge, so igniting the time fuse. The fol-

lowing fuses of this class are shown: Parrott, with water cap; Hubbell, with water cap; Stevens, with igniter; Rebel, with igniter, wooden plug; Laidley, with igniter and water cap; Laidley, with igniter; Hotchkiss, with water cap; Hotchkiss, with igniter and water cap; 3-inch gun, with water cap; Foreign, with igniter and water cap; Arick, with igniter; Taylor, with hood; Seacoast, with water cap; Navy, with water cap; Navy, with water cap and bushing; Hotchkiss, with water cap and igniter; Navy, with water cap; Adams's hand grenade, with igniter. The following forms, though more strictly time fuses, only, with special igniters, are placed on board 4 with combination fuses: Sawyer's, Armstrong's, and Shenkle's. A Swiss time fuse of recent form is also shown.

302. Impact fuses—concussion and percussion.—Concussion fuses are those that are ignited by the impact of the projectile at any point of its surface, and they are applicable to spherical projectiles. Percussion fuses are especially suited to elongated projectiles, and they are fired by the impact when the projectile strikes head on. In general, percussion fuses act by means of a plunger, which moves forward in the projectile on impact, and either strikes a percussion composition or draws a roughened wire through a mass of friction powder. Varieties of impact fuses shown are the Absterdam, Butler, Curran, old pattern Hotchkiss, James, Janezeck and Simpson, Laidley, Parrott, Patterson, Shenkle, Petman, and several of Rebel pattern.

The following percussion fuses of recent form are also shown, besides those described in detail below: Armstrong, German "Krupp," Driggs and Danish.

303. Combination fuses.—This name is given to fuses which, besides the time fuse to explode the shell within a certain time, have a concussion or percussion device which will explode the shell on impact if the time fuse fails, or if the projectile strikes before the time fuse is burned through. The following varieties are shown on board 4: McIntyre, Woodbridge, Drake, Treadwell-Splingard, Clapp, Tice, Belgian, etc. The Belgian illustrates the use of an annular time fuse in the combination.

The following combination fuses of recent form are also shown, besides those described in detail below: French "Walters," German "Krupp-Moffat," Swiss, Dutch, Russian, and Swedish.

304. Hotchkiss base percussion fuse.—This fuse consists of a brass screw plug, inclosing a plunger of lead surrounded by a brass band. A pin, slightly longer than the plunger, is embedded in the lead, with its point so far in that it can not strike the cap in the front of the fuse. The shock of discharge drives the plunger back on the pin, leaving the point projecting to the front, the lead still holding it tight. On impact, the plunger is thrown forward and the projecting pin explodes the cap. This fuse is intended to be placed in the base of a shell,

and it is made with a flange to act as a gas check and keep the powder gas from getting into the shell past the fuse. A front fuse, having the same kind of plunger, is also used by Hotchkiss.

305. Armstrong combination fuse.—(Received from Ordnance Office.) This consists of a brass fuse plug containing, at the front end, a cylindrical metal plunger, held in place by a soft copper wire, connecting it radially on one side with the wall of the plug. A primer is placed in the base of the plunger. The shock of discharge shears off the wire, throwing the plunger back and striking the primer against a projecting pin. This ignites a quick-burning composition on the inner side of a movable ring, and flame communicates through a small hole with the time-fuse composition, which is packed in an annular slot in the body of the plug. The ring can be turned to bring the hole over any desired part of the time fuse, and give proper length of burning to six seconds. In the rear part of the plug is another plunger, having a cap at the front end and a perforation through to the rear filled with quick powder. This plunger is double, consisting of a plunger of lead within a ring of brass. Before firing, the inner plunger, which holds the primer, is kept well to the rear of the cavity by a spring which surrounds it and keeps the outer ring forward. The shock of discharge drives the ring back, and, on impact, the whole plunger moves forward, the primer striking a pin projecting from the front of the cavity.

306. Gen. D. W. Flagler's fuse.—(Received from Frankford Arsenal.) This fuse is like the Armstrong, in having two plungers, the time plunger in the front and the impact plunger in the rear (as shown in the figure), but the means of holding them differ, and the fuse composition is arranged differently. The front plunger is held in place by an axial wire at the forward end, similar to that described in the Russian time fuse above. The rear plunger is made on the principle described in the new Hotchkiss percussion fuse. The fuse composition is contained in the movable ring itself, instead of in the body of the plug, and the latter has only a passage filled with quick powder leading to the interior of the shell. The parts are arranged to increase the sensitiveness of both the time and percussion parts, and especially to make them uniformly sensitive. A restraining disk protects the percussion igniter from the plunger when in the gun, and from pressures caused by the atmospheric retardation of the projectile during flight. This arrangement gives a very efficient and compact fuse, less than three-fourths the length of the Armstrong, enabling the point to be made more solid. It is graduated to burn up to twenty seconds.

307. Frankford Arsenal combination fuse.—(Received from Sandy Hook).—As in the Armstrong combination fuse, the igniter for the time train is in the front part and the igniter for impact in the rear part. The arrangement for igniting the time train is similar to that

of the Armstrong, except that the plunger before loading is held in position by a safety pin, which has to be withdrawn, while instead of copper wire to hold the plunger from accidental derangement, thin ears of brass project radially from the front of the plunger, and catch over a shoulder within the fuse, these ears being sheared off as the plunger moves backward on discharge of the piece. The other plunger is practically that of the Hotchkiss base percussion fuse. The special features of difference consist in the arrangement of the time train to provide for long ranges. This time train is set in a helicoidal groove in the outer surface of a hollow cone made of an alloy of lead, tin, and antimony, and this cone is covered by a brass cap pierced with holes which are arranged in a spiral over the time train, and spaced at intervals corresponding to seconds of burning, the spaces between consecutive holes being subdivided into fifths and pierced or countersunk at the divisions.

To adjust the fuse for any particular time of burning, a hole is punched from the outside through the time train and through the alloy cone, so that fire is communicated to the train from within on the discharge of the piece. An illustration shows the form of fuse punch and its method of use.

It will be seen that there is no movable ring employed on this fuse, as in the Armstrong, all exterior parts of the fuse being rigidly connected and immovable. The fuses are made to burn twenty-four seconds.

The construction of the time train is particularly interesting. A fuse composition is contained in a small lead pipe which is laid into the helicoidal groove on the exterior of the alloy cone. This is made as follows:

A lead pipe 12 inches long, 0.80 inch outside and 0.62 inch inside diameter, is charged with meal powder. Both ends are then closed and the pipe is reduced in 70 draws to 0.152 inch outside diameter. The length of the resulting train is about 23 feet. Comparative tests are made by burning lengths of 1 foot each. Figures show the charged pipe prepared for drawing, one end being reduced for passing through the die. The reduction in diameter for the first drawing is 0.02 inch, and the reduction greatly diminishes to the last drawing, when it is 0.002 inch.

The Schultz chronoscope is used in testing fuses for rate of burning "at rest," making possible more accurate comparison of results "at rest" than can be obtained with a stop watch, where personal error will enter. For service this has to be modified by experiment on the proving ground.

A percussion fuse from Frankford Arsenal is also shown.

308. Merriam base percussion fuse.—(Received from Ordnance Office.) This fuse is specially intended to secure explosion on impact,

even if the shell were to strike sidewise. The hammer which produces explosion of the percussion caps within the fuse is a heavy ball, which rests in a cup-shaped cavity in the rear portion of the body of the fuse. The curvature of this recess is of larger radius than that of the bore, so that the ball can have a lateral as well as a forward movement. The ball retains its position until impact, when it moves from its seat and impinges on small steel balls, which are placed a little distance in front of the hammer, and resting on the caps.

There are three caps and three small balls, with a view to making sure that one or another of them, if not all, shall be struck by the hammer on impact. The caps and small balls are placed in a separate piece, which is screwed into the front of the body of the fuse. This front piece contains the powder train and a special valve to retard the explosion slightly or to allow instantaneous explosion on impact. The ball hammer is held in place until the discharge of the piece by two retainers on opposite sides of the ball. Two tripping plungers, passing through recesses in the rear face of the fuse, rest against these retainers, and the force of discharge presses these tripping plungers forward and releases the retainers from the ball, so that the ball is free to move forward when the projectile strikes, being held against accidental dislodgment by a light spring in front.

Gas checks are placed in rear of the tripping plungers in the recesses in the base of the fuse to prevent gas being forced in by the explosion of the propelling charge.

PRIMERS FOR CANNON.

309. Friction primers.—The service friction primer consists of a small tube drawn from a flat disk of copper, filled with rifle powder and fitted with a branch tube at the closed end. This branch contains friction powder, and a serrated brass wire passes through it, ending in a loop outside. To fire the gun, the long tube is inserted in the vent and a lanyard is hooked to the loop of the wire. Pulling on the lanyard draws out the wire, igniting the composition by friction, discharging the powder, and communicating fire to the charge in the gun. An improved lanyard having a sliding handle is shown. The lanyard is held taut, and the slide is brought sharply up against a knot on the top. Besides the American, the German friction primer is shown.

310. Electric primers.—In these the tube is enlarged at the top for the insertion of an electric fuse, with wire connections for exploding the primer by electric battery or magneto-electric exploder.

311. Obturating primers.—These primers are so constructed that they prevent the escape of gas through the vent in firing. The tube is made of brass, larger in diameter than the old primer, and a screw thread near the closed end allows them to be screwed into the vent, enlarged and tapped at the outer end for this purpose. On some of

these obturating primers the screw threads are cut away in sections corresponding to slots cut through the threads in the vent, so that the primer can be pushed in and secured by one-sixth of a turn, as with the breech screw of the 3.2-inch rifle. The gas pressure forces the mouth of the tube against the walls of the vent and prevents escape of gas, the action being similar to that of the metallic cartridge. They are of two kinds, friction and electric primers. A hole in the solid end admits the wire for the friction primer, or the insulated wires for the electric primer. In the friction primers the wire has a swelling within the tube to prevent its being drawn completely out, and this fills the hole after ignition, preventing escape of gas. The electric wires of the electric primer pass through a disk of insulating material—vulcanized fiber—which covers the aperture from the inside and prevents escape of gas past the wires. Besides American forms of obturating primers, electric and friction, the Armstrong electric primer is shown.

312. Percussion primers.—Of these the following are exhibited: Vent-sealing Seabury primers and Armstrong percussion primers.

313. Percussion primer pistol for firing cannon.—This consists of a wooden stock about 3 feet long, having a pistol handle at the rear end and a percussion lock at the front end. A trigger close to the handle works by means of a long lever to release the hammer and allow it to fall on the percussion primer, which rests in a perforated holder fixed to the front end of the stock. In use the primer would be placed over the vent of the cannon and there exploded. A spring is arranged under the forward end of the stock, this spring being drawn up before firing and secured by a catch which is released as the hammer falls, the blow of the spring striking up the end of the pistol out of the way of the blast from the vent. The date when this was used is not known. The pistol was contributed by Mr. John H. Martin, superintendent of Washington's headquarters, Newburgh, N. Y., where it was found when the building was occupied as a museum.

314. Cannon vents.—Board containing 21 specimens showing enlargement of cannon vents by firing.

POWDERS FOR CANNON.

315. Black and brown powders.—Until within a few years the composition of gunpowder has varied but very slightly from the ancient formula. In early times powder was used simply in the form of meal, and granulation of powder was not known until about 1429. Toward the end of the fifteenth century three sizes of powder are said to have been known, but extreme attention to granulation of cannon powders was not paid until very recent years, when the size, regularity, and density of grain were carefully proportioned to the guns of different caliber. To General Rodman, of the Ordnance Department, is due the

development of a powder which would burn on an increasing surface so as to produce more and more gas as the grains burned. This was exemplified in his perforated cake powder, which, in a modified form, is shown in the prismatic powder which was developed in Russia and other European countries and then reimported for use in our service. Many attempts were made to produce the desired result of lessening the initial pressure and the maximum pressure, and maintaining the pressure while the projectile was in the bore (these being the effects of the Rodman powder), and as early as 1873 Dr. Woodbridge introduced a progressive powder, so called, in which a mass of fine-grained powder was inclosed in an envelope of compressed powder. The object of this was to produce slow burning until the envelope was burned through, when the interior grains would be consumed rapidly. Another powder intended to produce this result was the Italian Fossano powder. This might be called a conglomerate powder, in the manufacture of which grained powder was mixed with meal powder, and the mass compressed in cakes, which were then broken up into grains of the size desired. The first marked change in composition was illustrated in the brown or cocoa powder, in which the ordinary charcoal previously used in the manufacture of gunpowder is replaced by a grade of under burnt charcoal, which retains a certain proportion of hydrogen and oxygen and maintains its cellular state, even after having been ground very fine, so as to more readily combine with the oxygen liberated from the niter upon explosion of the charge. To this charcoal "carbohydrates" are also added.

This powder possesses great ballistic force, and the smoke produced is much less than with the ordinary black powder, but great difficulty has been encountered in obtaining uniformity in its manufacture and uniformity of effect in its use. On account of its hydroscopic nature it is liable to vary, and the pressure in the gun modifies its rate of burning much more than with black powder. Specimens of powder of various grains are shown, from that used for field guns to the large blocks used for heavy guns. Samples of large grain powder—hexagonal, spherohexagonal, mammoth and cubical—with some of the prismatic perforated grains, both of black and brown ("cocoa") powder, are shown; and cartridges, such as are used for the United States 12-inch rifle, are exhibited, made up of wooden blocks representing the prismatic grains.

316. Smokeless powder.—The introduction of smokeless powders for small arms led to attempts to apply them to large guns, but the greatest difficulty found at first was in the high pressures produced by these powders, the explosion of the early powders possessing something of the nature of a detonation. It was not until it was found that they could be deprived of the property of detonating, and until their rate of burning could be regulated by size and form of grain, that they offered much promise for cannon.

Nitro compounds and organic nitrates are most extensively used for smokeless powders. A number of different varieties of foreign and domestic make have been tested. The following specimens are exhibited: Leonard's tubular (American), for 3.2-inch breech-loading steel rifle; Gorman smokeless powder, for 8-inch breech-loading steel rifle; Troisdorff, for field guns; cordite (English), for field guns; B. N. (French), for field guns.

SMALL-ARM CARTRIDGES.

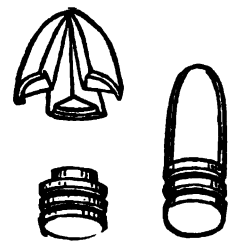
Historical collection of small-arm cartridges.

317. Board of bullets.—This shows about 100 varieties, and embracing the French bullet for the carabine à tige, one of the earliest forms, made to rest on a pin projecting from the bottom of the bore, and forced into the rifling by blows of the ramrod; the Minie bullet, made with a hollow base to allow expansion by pressure of powder in firing; Jennings, containing powder charge in base; the Austrian explosive bullet for blowing up ammunition chests; also many others, showing steps of improvement to the present day.

In addition to these bullets there is shown a steel bullet with a copper ring, like that on the Butler shot for heavy guns, to take the rifling. This was devised by Maj. Geo. W. McKee, Ordnance Department, to be fired from the .45 caliber service Springfield rifle in experiments on iron and steel plates of moderate thickness, for calculation of effect of large steel shot on heavy armor.

A bullet coated with copper, made at Colt's armory as early as 1884, is also shown, with specimens of the new small caliber lead bullets sheathed with copper and steel, and one of very recent pattern wound with steel wire.

An interesting revolver bullet of recent invention is shown in figure 25. This is made up of two parts, one solid forming the base, and one split at the rear into three sections, but united at the point. The figure shows the separate parts, and on their right the appearance of the whole bullet prepared for loading. In firing, the parts separate, and though the penetration is not very great, it is claimed that at short range it is very effective, particularly for mounted practice. This bullet is the invention of Capt. Henry J. Nowlan, Seventh Cavalry, who claims that pistol practice should not be attempted by mounted men except at very short ranges.



318. Cartridge primers.—A collection of cartridge primers and parts of primer is shown, embracing different varieties—Berdan, Orcutt, Sharp, Wesson, etc.

319. Board of cartridges.—Fifty-six specimens of foreign and

American cartridges are arranged on a board received from the Military Academy. These include, with many others, some of the earlier forms of self-primed cartridges; the needle gun cartridge; Morse's American cartridge, with metallic shell and rubber base, 1858; Boxer cartridge, thin brass, wrapped, with iron head, for Martini-Henry rifle.

320. Cabinet of cartridges.—This shows the progressive stages of manufacture from early cartridges for muzzle-loaders to the United States .45-caliber cartridge. The cartridges in this collection are from Frankford Arsenal, having been prepared for the ordnance exhibit at the Centennial Exposition. A detailed description of these cartridges will be found in Captain Metcalfe's report on that exhibit:

1. Paper ammunition, not fixed: Round and elongated bullet and buckshot cartridges; powder and bullet wrapped in a paper cover. Twenty-five specimens.
2. Paper and linen ammunition, fixed: Wrapper round the powder inflammable. Could be inserted whole. Used both for muzzle-loaders and for the earlier breechloaders. Cartridges for Merrits's, Hall's, Sharps's, Colt's, and Starr's arms are noted. Twenty-nine specimens.
3. Transition from inflammable wrapper to metallic cartridges: This includes the Gallagher foil cartridge; the Maynard brass-shell cartridge, with a flange at rear, as in modern cartridges, but having no priming, a central perforation in the base admitting flame from a primer fired on a nipple outside the barrel; the Burnside copper-shell cartridge, with flange at forward end, and central perforation at base; also some foreign gun cartridges. Thirty-seven specimens.
4. Early self-primed cartridges, rim-primed and center-primed cartridges: Poultney brass foil with iron base; Crispin zinc foil; Hotchkiss solid head, pressed up from solid base; Remington-Martin base; Winchester (Milbank primer). The primer is a flanged percussion cap inserted in a pocket without anvil; United States Cartridge Company solid head, both inside and outside primed cartridges; Berdan, early forms with outside pocket, and impressed shallow cup; Mead's explosive bullet cartridge; Spencer; Ballard; Morse; Henry; various experimental cartridges, including Colonel Laidley's; and several pistol cartridges by various makers, including inside and outside cap, teat and rim-primed cartridges.
5. Foreign and sporting cartridges, metallic, etc.: English Boxer, Snyder; English Boxer, Henry; French chassepot and mitrailleuse, pasteboard, with metal base; Prussian needle gun, paper cylinder, choked in front of bullet; Austrian "Werndl," with annular copper anvil; Dutch Beaumont, with solid brass head and pocket, cap with anvil primer; Swiss Vetterlin, rim primed; and various sporting cartridges for shot, nearly all pasteboard, with metal base, pocket, and anvil primed.
6. Modifications made in the charge (caliber .50 cartridges): Charges of Oriental, Hazard, and DuPont musket powders 70 grains. These show the various effects of compressing the charge, either from front, rear, or from both ends, and either perforating it from end to end, or leaving a conical rear cavity; Sleeper's chlorate powder is also shown in charges of from 15 to 30 grains, as is also Gomez's iron gunpowder.
7. Modifications in bullet and lubricant: These show the various effects of deepening the cannelures to hold more lubricant; use of two broad cannelures instead of three; use of lubricant with wad under the bullet, either alone or in addition to lubricant in the cannelures; use of a front lubricant; patching bullet with banknote paper and use of bullet hardened by the addition of tin. Various forms of

bullets are also shown, the usual one being the frustum of a cone on a cylinder; various reductions in weight are also made, usually by conical cavity in base.

8. Center-primed cartridges, disk and bar anvils: These show the center swell base, copper-disk anvil, two vents, short case; Martin straight bar reenforce, tinned iron, with reenforce copper cup held in by indents in wall of shell; various disk and bar anvils of copper or iron, held in by indents or reentrant fold; and the Martin pocket with reentrant fold. Cap-primed cases are included. These show the solid nipple head in brass pocket in base of case; various star and cup cap-receivers; front ignition cases; the Laidley arch anvil; Treadwell cube anvil; Berdan anvil; and cup anvils. One of the earliest was the Benét, 1866. One of Berdan's early models was made on the same principle. They also comprise the tinned cup anvil, held in by crimps or indents; side-vent cup anvil; corrugated base, copper-cup anvil; copper-cup anvils of various shapes; Treadwel's open base, with double cup; Berdan's solid head teat anvil, and various cup-anvil ammunition for pistols.
9. Modifications in caliber. Reductions: Nearly all the first bullets of .45 caliber are in bottle-shaped cases, either for 70 or 80 grains charge, weighing from 400 to 425 grains; they are nearly all cannelured, with cases about 2.5 inches long. The bullets for the .42 caliber are used with from 70 to 80 grains of powder, and weigh from 350 to 385 grains. The early forms all appear in bottle-shaped cases, and are nearly all cannelured. The .40 caliber, nearly all in straight cases, are used with from 65 to 80 grains of powder, and weigh from 290 to 350 grains. They nearly all have four or five cannelures.
10. United States folded head, center-primed cartridges; caliber .45; nonreloading, showing stages of manufacture: The shell is slightly tapering from flange to bullet, where it becomes cylindrical and extends to cover the cannelures. It is made from a thin plate of copper. First a disk is punched out and slightly cupped in a single machine. The cup is then drawn out more and more, becoming of smaller and smaller diameter by successive operations. It is then trimmed to length, and the head is formed by a press which buckles out the metal at the sides of the closed end, forming a folded flange. A perforated cup anvil, with a shallow pocket in the bottom, is inserted and pushed down, being fixed in place by crimps made just in front of it at two opposite points in the wall of the shell. The bullet weighs 404 grains; charge of powder for carbine, 55 grains; for rifle, 70 grains, the same shell being used for both, with wads behind bullet in the former to fill the space and give the cartridge the same size. The bullet is made from round cast bars of lead and tin; 16 parts lead to 1 of tin. These are rolled down to size, and then a single machine cuts to lengths and forms a bullet from each length between three dies, one die for the base and two for the sides. There are three shallow cannelures for lubricant. Samples are given of carbine, rifle, and revolver shells and bullets, showing stages of manufacture.

321. United States solid-head cartridge, caliber .45.—This differs from those just described, in being made with a solid flange at the head, and arranged for the insertion of a primer from the outside, so that the shell can be reprimed and reloaded. It has usually been made of copper, but it is now made of brass. It is made from thicker metal than the folded-head cartridge. The sheet from which the disks are punched is shown, with the various stages in development of the tube, primer, and bullet. Weight of bullet, 500 grains; weight of powder, 70 grains.

322. The Morse shell of caliber .45—This has a movable base, with

rubber packing. It is a folded-head brass shell, with the center of the base cut out for the insertion of a solid cup containing an outside primer. A rubber ring inside covers the joint. With the solid-head cartridge, expansion of the front part caused it to clamp against the wall of the chamber, the pressure on the base tending to pull it away from the front part so held. This caused breaking, particularly with copper shells. The Morse shell was designed to obviate this trouble and make the shells last longer for reloading.

New small caliber cartridges.

The tendency to reduction of caliber has been constant from the old musket caliber, seventy one-hundredths of an inch, to the prevailing calibers of recent years, .45 (the United States caliber) to .40.

To Professor Hebler, of Germany, and Major Rubin, of Switzerland, is due the credit of experiments within the last fifteen years which have led to recent reduction of calibers in Europe. The limit of advantage in reduction was at first thought to be about 0.295 inches, and a caliber of about .31 was regarded as the best, but calibers of .256 are now in use, and our Navy has adopted a caliber of .235. The new United States Army caliber is .30.

The object of reduction, besides the saving in weight of cartridges and of space occupied by them in packing, and the diminution of recoil, lies in the flatter trajectory obtained with a bullet of diameter so slight as compared with its length. Such a bullet in moving point on suffers less resistance from the air in proportion to the weight, since the weight of projectile compared with resisting surface is greater. The retardation of the bullet is therefore less. Moreover, the area of the longitudinal section is greater in relation to the weight, and this increases the effect of the air in retarding the drop of the bullet. The result is that the velocity given it in the gun is maintained longer and the drop is less over a given range, as well as in a given time, making the path of the bullet straighter and increasing the "dangerous space," or the distance over which, for aim at any particular range, the bullet would keep within a man's height from the ground. This effect is augmented by greatly increasing the charge in comparison with the weight of the bullet, or by using a higher explosive, and so getting greater initial velocity, 1,800 to 2,000 or even 2,300 feet per second, instead of 1,300 to 1,400 feet. To keep a long, thin bullet point on in its flight requires and increased rate of rotation, and the twist of the rifling is increased to 1 turn in 9 or 10 inches, while the twist in our service rifle is 1 turn in 22 inches. Lead bullets, unprotected, will not stand this under high charges without stripping, so the lead bullet is sheathed with copper, German silver, or steel, and this covering assists, too, in penetration. A copper-covered bullet recovered from wood into which it had been fired is shown. It bears the marks of the

rifling, but shows no deformation.[a] The Hebler and Rubin cartridges differ in details as follows:

323. The Hebler cartridge.—In one form of this cartridge the case is of steel, nickel plated, with a copper head which contains the center-fire capsule and expands to serve as a gas check. The charge of powder, 83 grains, is compressed in the case, and has a central canal for the rapid ignition of the whole charge. It is arranged in layers of different densities, to give greater uniformity of pressure by increasing the rate of burning toward the end. The form shown in the exhibit, from the National Armory, represented actual size in figure 28, has a brass, solid-head, bottle-shaped shell, with the usual flange.

The Lorenz bullet, used with these cartridges, is covered with a thin steel jacket, nickel plated. This jacket is drawn and pressed into shape, tinned inside, and filled with compressed pieces of soft lead slightly hardened by tin and antimony. The whole is then heated to melt the lead and cause it to unite with the wall of the cover, and the lead is afterwards compressed and solidified. The steel jacket is tempered at the point, but it is softer at the sides. Six thousand rounds have been fired from a rifle without perceptible wear or injury to the grooves, the bullet taking the grooves perfectly. The bullet has no cannelures.

The following figures regarding the Hebler bullet, caliber .295, are taken from various sources: Initial velocity, 1,850 feet; weight of bullet, 224 grains; weight of charge, 83 grains; weight of cartridge complete, 521 grains; length of bullet, 4.46 calibers. Penetration of Hebler at muzzle, 39.4 inches in pine; at distance of 2,500 meters, 2¼ inches. Of Mauser at muzzle, 9.5 inches; at 1,600 meters, 2.16 inches.

The Lebel rifle cartridge, of the Hebler pattern, is said to be as follows: Length of bullet, 1.32 inches; total length of case, 3.07 inches; caliber, .304; weight, 211.42 grains. Front lubricant is supposed to be used. This cartridge has a smokeless powder, but its composition is not definitely known, and there is some doubt about its standing storage and answering the requirements of service.

324. The Rubin cartridge, lead bullet, copper covered.—Two specimens are shown, of form indicated in figure 29; one from the National armory, and one presented by Herr Schulhoff and Major Glentworth, of the Austrian service. This is used in the Shulhoff magazine gun, shown in the exhibit, as well as in the Rubin rifle, of which a trial is now being made at the National armory. This shell is of a novel pattern. It is made without a projecting flange, a groove for the extractor to engage in being cut round the base, which is made thicker to give room for it. The walls of the shell are thick, and at the mouth this is increased by an inner ring, forming a shoulder round the bullet, and this, with the taper of the shell, prevents forcing the cartridge too

[a] This jacketed bullet originated with the Winchester Company, of New Haven, in 1879, for use in the Hotchkiss gun.

far into the firing chamber. One advantage of this form of shell in box magazines is obvious, as no care has to be taken to keep the flanges of the cartridges from catching on to each other to prevent pushing the top one forward in loading the piece. The Schulhoff gun is also made to fire the Hebler flanged cartridge. The following information regarding the Rubin cartridge, of form shown in figure 29, is derived from experiments in this country with the Rubin rifle: Caliber, .295 inches. The charge is ordinary grain powder, compressed, with an axial perforation. Weight of powder, 69.48 grains; weight of projectile, 216.16 grains; velocity at muzzle, 1,800 feet per second; maximum penetration in soft pine, 17 inches at 500 yards; 9.78 inches at 1,000 yards; ordinates in firing at 500-yard target, 100 yards, 2.97 feet; 200 yards, 4.8; 300 yards, 5.19; 400 yards, 3.73; maximum ordinate firing at 1,000-yard target, 34.226.

325. The Hurst accelerating cartridge, caliber .32.—A cartridge invented by H. P. Hurst, of Mississippi, has attracted considerable attention. (It is shown only by drawings and description.) Remarkable results are claimed for such a cartridge, with the weight of charge nearly double that of the projectile.

The base of the cartridge shell has attached to it a strong central tube, which contains the initial charge of powder, and extends beyond it over nearly all of the cylindrical portion of the bullet. Outside of this case is disposed a second charge, composed of rings of compressed powder considerably less in diameter than the chamber of the gun. The bullets are made of steel, and are of various lengths. The firing of the central charge is effected in the usual manner, and the bullet is driven from the tube, but the very instant it is clear the flame is communicated to the second charge, and the projectile leaves the bore with a greatly accelerated velocity.

326. Cartridges of various nations.—Specimens of the following small-caliber cartridges are shown in the exhibit. The dimensions, weight of charge, kind of powder, etc., will be found in the table following the review of magazine guns. The accompanying figures show the cartridges in real size: Lee-Speed (English), Mannlicher (Austrian), Mannlicher (Roumanian), German models of 1876 and 1878, Belgian, Italian, Norwegian, Danish, Portuguese, Japanese, and United States models.

327. Samples of powder for small arms.—Besides samples of ordinary black gunpowder, the following smokeless powders appear: Leonard, Peyton, Wetteren, Troisdorf, cordite, French B. N. F., Riflette, and Axtell.

Of the domestic smokeless powders, the Peyton and Leonard varieties have given the best results. So far these powders have not been obtained in quantity, and for experiment the Wetteren powder, made in Belgium, has been most extensively used. The early forms of this

powder contained nitroglycerin, but on account of its corroding the gun this has been abandoned as an ingredient.

Ballistic effect of new cartridges.

The natural result of the disposition to adopt a small-caliber cartridge was to stimulate the efforts to obtain a powder which would not foul the gun. Attention was thus forcibly drawn to improvement of the nitrate powders already used to some extent for sporting purposes, and success has followed in many instances. Incidentally it appeared that the smoke resulting from discharge was very slight, obviating the clouds of smoke that usually followed the discharge of firearms, and this is now regarded as a very valuable element in the cartridge, as it is more difficult for the enemy to detect the point from which shots are fired. The new powders give very high chamber pressure, varying from 14 to 21 tons per square inch, demanding increased strength of barrel and breech mechanism. Much less smokeless powder is required to make up a charge than with other powders, the weight being a little more or less than half the old weight, according to the nature of the powder used. Although a smokeless powder for the ammunition has not yet been adopted for service, a sufficient quantity of the Wetteren powder has been ordered to furnish what is required for immediate needs, pending the now very encouraging outlook for securing a suitable powder of domestic production.

The new bullets are now much longer in proportion than the old, being about 4 calibers in length, and they have a much higher velocity. This gives to the bullet, especially as its envelope is of harder material than the lead, an increased penetration at all distances.

The specifications of the board for the United States ammunition require a weight of bullet of 220 grains and a charge of 36 to 40 grains of smokeless powder, or such lesser weight as will give a muzzle velocity of about 2,000 feet per second, with a chamber pressure not exceeding 45,000 pounds per square inch. These conditions it is found in practice, however, can be considerably ameliorated, and a higher velocity obtained with considerably less pressure from several of the samples of smokeless powder that have been tested. This ammunition will not be reloaded by troops.

The changes made in the components of the experimental .30-caliber cartridge to adapt it to the magazine rifle, model 1892, consist in a reduction of the weight of the bullet from 230 to 220 grains, and of its diameter from 0.309 to 0.308 of an inch, and the substitution of German silver for the copper covering (jacket) of the bullet, which is made without cannelures and is not lubricated. The exterior dimensions of the cartridge remaining the same, there is a consequent increase in the powder space due to the shortening of the bullet. The bullet (within the cover) is made of an alloy of 12.5 per cent tin and

87.5 per cent lead. The German silver jacket may be regarded as tentative, since experiments with a cupro-nickeled steel jacket have shown superior results as regards penetration and resistance to deformation. Fired into oak, against the grain, at a distance of 3 feet, penetrations were found as follows: 230 grains, copper jacket, 4 inches, bullet badly deformed; 220 grains, German silver, 5.3 inches, bullet badly deformed; 220 grains, nickeled steel, 19.5 inches, bullet not deformed.

Compared with this, the uncovered .45-caliber bullet of the Springfield rifle gave a penetration of 3.2 inches at a distance of 50 feet; bullet badly deformed. Fired into dry, well-seasoned oak, at a distance of 3 feet, the .30-caliber 220-grain bullet with cupro-nickeled steel jacket gave a penetration of 24.2 inches, bullet not deformed. The range being 500 yards, it is found that the greatest height of trajectory of the .30-caliber rifle is 3.85 feet (this point of the trajectory is 300 yards from the muzzle). The same greatest height for the .45-caliber Springfield rifle is 8.16 feet, and for a .40-caliber Remington-Hepburn rifle 7.7 feet. These results show the flatness of trajectory and consequently increased danger space of the .30-caliber rifle in comparison with the others.

Recent experiments were made at Frankford Arsenal by Assistant Surgeon La Garde, of the United States Army, and Lieutenant Benét, of the Ordnance Department, to test the effect of the .30-caliber bullet upon animal tissues and bone.

It was made the object of these experiments to compare the effect of bullets of large and of small caliber upon the same parts of the human body at various ranges up to and including 2,000 yards. The arms used were the .45 caliber Springfield rifle and the experimental .30 caliber Springfield rifle, using the ammunition of and having the same ballistic qualities as the magazine rifle, model 1892. The objects to be fired at were placed at short range, and reduced charges were determined for the rifle to obtain the striking velocity of bullet incident to actual ranges simulated. As regards the nature of wounds produced, it is concluded that their severity is much less with the smaller caliber, and that the severity at short ranges will be further lessened by using a bullet which will be seldom or never deformed at the highest striking velocities against the hardest human bones.

As the reduction of velocity due to diminishing the charge also diminishes the rate of rotation, and in a greater proportion than would occur from the flight of the bullet through the air, experiments at long ranges will be made to determine the actual effect due to the spinning of the bullet under service conditions.

It is said that experiments on animals demonstrate that the wound caused by a Hebler bullet is much less serious than that from others, as the Hebler bullet makes a clean hole, while the others make ragged and splintered holes, producing wounds that remain serious for years, even if vital parts are not struck. In one case a man shot by a Hebler bullet in the upper left arm entirely recovered in three months, though he was hors de combat for two months.

A bullet which will not be deformed is preferable on account of its penetrative power and ability to wound several instead of one man.

The caliber .30 is the same as that of the Russian arm, and intermediate between the arms of Austria, Belgium, England, France, and Germany, which are the larger, ranging from 0.301 to 0.315 of an inch, and those of Holland, Italy, Spain, Roumania, and Switzerland, which are smaller, ranging from 0.256 to 0.295 of an inch. At the present time there is a tendency of professional opinion to the use of a smaller caliber than .30. The gain at most can be but slight.

328. Bullets recovered after firing.—The deformation produced in bullets by firing them into sand and against iron plates is shown in the accompanying illustration, the United States service bullets, caliber .45 lead and caliber .30 jacketed, being used in the experiments:

First row.

[Fired into sand at 100 yards.]

Caliber		.30
Weight of bullet	grains..	220
Charge of powder Wetteren	do....	36

Second row.

[Fired against iron plate at 100 feet.]

Caliber		.30
Weight of bullet	grains..	220
Charge of powder	do....	14

Third row, except last bullet.

[Fired into sand at 100 yards.]

Caliber		.45
Weight of bullet	grains..	500
Charge of powder	do....	70

Fourth row.

[Fired against iron plate at 50 feet.]

Caliber		.45
Weight of bullet	grains..	500
Charges of powder:		
No. 1	do....	3
No. 2	do....	5
No. 3	do....	6
No. 4	do....	7
No. 5	do....	8
No. 6	do....	9
No. 7	do....	10
No. 8	do....	69
Last bullet, third row	do....	12

Supply of small-arm ammunition.

The supply of ammunition in the field has become a question of increased importance with the introduction of magazine guns and automatic machine guns, the possible rapidity of fire far exceeding in pro-

portion the increased number of cartridges that can be carried with the same transportation on account of decrease of weight. For the small arm of caliber .30 this amounts to 175, to 100 of the .45-caliber cartridges, and the reduction of caliber to less than .25 still further increases the proportion.

A method proposed for the old .45 caliber cartridge was to strap together in square packages of 10, the paper boxes containing 20 cartridges, these packages being of convenient size to be readily carried by hand to supply troops, or packed in the limber chest of machine guns. For ordinary transportation three of these packages would be placed in a wooden box which one man could readily handle, and which could be conveniently packed on mule back when necessary or in special ammunition carts. This was projected by Col. E. B. Williston, who made the boxes with a fastening that could be opened without tools to get at the ammunitton. In the old form with a fixed lid, to save waste of time in unscrewing the lid in action, the boxes often had to be broken open by dashing them to the ground.

The use of packages as above described was suggested before the late improvements in magazine guns and machine guns. It was supposed that the ordinary paper packing boxes would continue to be used with machine guns, as in the Bruce feed, while at the same time it was thought that the small-arm magazines might be arranged to fill directly from the same paper boxes.

The tendency now is, however, to feed ammunition to machine guns from a tape or strip, and unless a similar method is adopted for small arms, it seems probable that machine guns and small arms will require distinct methods of packing, particularly if the use of magazine chargers or clips continues. A woven belt with a double row of loops for cartridges has been made for our service, and one holding cartridges in groups of five has been proposed. The original use of cartridge belts in the old form, called the Prairie belt, with loops of cloth or leather bound on to the belt, seems to be due to Col. Anson Mills, of our Army, who afterwards invented machinery for weaving the belts in one piece. The Mills woven cartridge belt with arrangement for carrying Lee magazines is shown; also the Orndorff modified form as recently proposed, with illustration of a method of packing these belts (already filled with cartridges at the arsenals) in wooden boxes for transportation.

It is believed that the use in this manner of a light, cheap belt of this description was first proposed by Maj. G. S. Wilson, of the Adjutant-General's Department, while a lieutenant in the Twelfth United States Infantry, who made his belt by simply folding a strip of cloth lengthwise, catching the folds together at intervals and allowing place for the cartridges. The loops for the cartridges were then closed at the bottom. The Orndorff form is woven in one piece to

produce the same result. By thus supplying belts ready filled, a great many cartridges can be carried readily by men running between the fighting line and the boxes where they obtain the belts. The new arm in our service is not dependent on magazine chargers, but some provision may have to be made for carrying them, as in the belt illustrated in description of the Lee magazine gun, and in the Mills belt shown above.

The waste of ammunition in the days of flintlock guns, and later with muzzle-loading percussion-lock guns, made the expense and difficulty of supplying munitions many times greater than with the modern metallic cartridge, notwithstanding the more rapid fire of breechloaders and the increased cost of single cartridges.

METALLIC SHELL CARTRIDGES.

To Lefaucheux, in 1832, belongs the credit of giving the first impulse toward the adoption of the modern self-primed cartridge. His was a paper-covered cartridge, having a base formed of two disks, one of brass and the other of pressed paper, with the priming composition placed between. A metal pin, projecting at the side, fitted into this base. This pin, when struck by the hammer, exploded the charge.

Flobert, in 1845, developed this principle, and used the cap itself as the cartridge shell containing the powder and shot, thereby making the cartridge its own obturator. The Lefaucheux cartridges commonly in use after this combined both principles. The pin also assisted in extracting. About 1857 United States manufacturers took up the development of the metallic shell cartridge in the improved form devised by the American, G. W. Morse, and they have carried it to its perfection.

It is said that Pauly, who tried to introduce the Ferguson percussion system into France in 1808, devised a breech-loading gun with a hinged breech similar to the Palmer and Allin forms, and that as early as the year 1812 he introduced a gas-tight metal cartridge shell of sheet brass, for central fire, which was fitted with a flange. This had a separate head of wood or metal with lead to close the joint, after the manner of the Morse cartridge, in which India rubber was used. The ignition was produced by the compression of air by means of a small piston.

Some of the early shells were unprimed, like the Maynard and Burnside, and in the transition stage some were made with tin or brass foil sides attached to a rigid base. The solid drawn shell of copper or brass is now universally used.

One great advantage of the metallic shell, besides its convenience in holding the whole cartridge together, is that it acts as a complete gas check, on account of the expansibility of the shell at the front

edge. This is not so apparent with the steel forms used in the first two guns, and steel is now practically replaced by copper or, preferably, brass. The difficulties encountered in providing a proper gas check for guns using paper cartridges led to the adoption of the metallic shell in spite of its additional weight. Though for shotguns the shells are often made of thin steel, and shells with paper walls are common, they are not now used for military arms. The paper shell, so called, of the present day, is quite distinct from the old "paper cartridge." The metallic ammunition has been the chief factor in making breechloaders, and particularly magazine guns, a succes.

Even for cannon of medium size the tendency is to use metallic shell ammunition to facilitate rapid loading.

140. Roberts breech-loading rifle, 1862, metallic cartridge.—The breechblock is attached to the under part of a lever which is hinged to the top of the barrel a little in front of the breech. When open, the lever is swung upward and forward, carrying with it the breechblock, the lever lying on top of the barrel. In closing, the lever is swung backward and downward, the breechblock dropping into a vertical mortise in rear of the barrel. To allow this motion of the block, the block has a limited sliding play along the lever. The cartridge shell is made of steel so that it can be used over again. It has a little hole in the right side of the shell, facing the tube from the nipple, to admit fire from the percussion cap.

141. Spencer single-firing rifle, removable steel loading chamber.—This has a thin removable steel loading chamber, like the system described above as of the earliest model known. The chamber can be taken out and reloaded. It was probably intended to have a number of these chambers loaded for use, and therefore the gun is placed in this class.

142. Early French breech-loading rifle, caliber .58.—System somewhat resembles "Sharps" (no marks); probably used with Lefaucheux cartridge. Pin fire.

143. Burnside rifle carbine, caliber .54, 1856.—Movable chamber pivoted in front under barrel, held close by cover on transverse shaft, operated by side lever. Used an unprimed metallic cartridge, the front part of the shell covering the joint between the breechblock and the barrel to prevent leakage of gas. Central fire, perforation in center of base admitting flame from cap placed on an outside nipple. In closing, the breechblock has a forward movement, so that the bullet projecting from forward end of chamber is pushed into the rear of the barrel. A number of these arms were used at one time by the United States for cavalry.

144. Burnside carbine, caliber .54.—This differs from the above in the locking device, consisting of a barbed catch on the receiver, connected with a pivoted thumb piece on the inner side of the guard.

Fifty-five thousand five hundred and sixty-seven of these guns were purchased for use in the Army during the civil war.

145. Maynard breech-loading carbine, caliber .50, 1850.—Leaf sight, metallic cartridge, unprimed, with hole in base to receive flame from percussion cap. A lever underneath, pressed down and forward, moves the breech end of the barrel upward to receive the charge. Closed by reverse motion; extraction by hand. The cartridge shell from Maynard gun has a flange at the base to keep the charge from going too far into the chamber, and to assist extraction. Except that it was not self-primed, and that it had to be fired by use of an exterior primer, the flame being admitted through a central opening in the base, this cartridge corresponded closely with the modern center-primed cartridge. The gun was fired either with the common percussion cap or with the Maynard tape primer described under muzzle loaders. There were 20,002 of these guns purchased by the United States Government for use in the civil war.

146. Howard's breech-loading carbine, faucet breech, caliber .43, patent, 1863.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. Rim-fire. Firing pin worked by hammer on side. A small cylinder revolves on its axis, and contains the charge. When fired the firing pin presses this forward against the barrel.

147. Morse's system, 1858, Wilson and Flather's alteration of smooth bore, caliber .58.—Essentially the same principle as the Morse. The cartridge is rim-fire, fired by a side lock; the parts not so well proportioned as in the Morse, and the breech not so securely locked as in that arm. This arm is provided with an automatic ejector, rising from the bottom of the receiver to throw out the cartridge after it has been withdrawn by the extractor.

The Morse system is opened by raising a flap hinged at rear to butt of barrel. This, by means of a link from the middle point, operates a breechblock which travels back and forth in the cavity exposed by raising the flap. A center-fire cartridge, with rubber base, was used, one of the earliest of the metallic shells.

148. Freeman's breech-loading rifle, caliber .50, 1870, metallic cartridge.—Opened by swinging back breechblock by the thumb piece in front. Locked by the position of the breechblock and by help of hammer. Extraction and ejection by sliding extractor underneath seat of block, which operates in connection with it.

149. Sharp's carbine.—This works on the same principle as that described for paper cartridges, except that it is adapted to metallic shell, rim-fire cartridge. The nipple is removed, and the hammer strikes a firing pin which slides obliquely on the right-hand side of the sliding block. Many of these arms were issued to troops during the rebellion, and were used in the cavalry after the war until replaced by the Springfield breechloader; 80,512 guns of the Sharp system were

purchased by the United States Government for use in the civil war.

150. Allen's breech-loading carbine, breech slides in vertical mortise, caliber .40, 1860.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. The breechblock slides up and down in a mortise just in rear of the barrel, and it is operated by a lever also serving as a trigger guard. The hammer is in the center of the stock and strikes a firing pin passing through the breechblock.

151. National breech-loading rifle, .52 caliber, rim-fire, D. Moore's patent, 1861.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. The breechblock consists of two parts, the rear one sliding in a vertical mortise, and the front one sliding to the rear, both operated by a brass lever which also serves as a trigger guard. The front one carries the extractor and also the firing pin. The withdrawal of the front section of the block by the lever forces the hammer back to the half cock.

152. Comblain rifle, with saber bayonet, caliber .45.—Partially adopted by the Belgian Government. By depressing the lever the breechblock slides downward to expose the chamber; the motion of the lever cocks the hammer meanwhile.

153. Ballard rifle, caliber .54.—By depressinga lever the breechblock is caused first to recede from the barrel and then to drop downward, revolving about a shifting horizontal axis at its lower and rearmost corner. Hammer and lock concealed in the breechblock. Rim-fire cartridge. The cartridge shell is extracted by means of a sliding extractor beneath the barrel, moved independently by hand by means of a finger piece projecting beneath the tip stock. Depressing the stock leaves the hammer at half-cock. Block can not be depressed when hammer is cocked. One thousand five hundred and nine of these guns were purchased for use in the Army during the civil war.

154. Norny's alteration of muzzle loader, caliber .58.—Opened by drawing back a lever pivoted underneath the stock in front of the trigger guard. The lever has a link connecting it with the butt of the barrel, so that by the above operation the entire barrel is slid forward in its bed between the stock and the band. Loaded with a cartridge inserted by hand into the chamber. Closed by reversing the movement of the lever, which is secured when closed by means of a turn screw at its forward end. Fired by the ordinary side lock, the face of the hammer being prolonged and sharpened to strike the rim of the cartridge. Cartridges extracted by the beveled stud on the face of the breech screw.

155. Sharp and Hankins's breech-loading rifle carbine, caliber .52, 1859, metallic cartridge.—Operated by a lever underneath the barrel. Depressing the lever moves the barrel forward for the insertion of the cartridge. Closed by reverse movement.

156. Rowe's breech-loading carbine; barrel turns on longitudinal pin, caliber .50, 1864.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. The barrel rotates to the right on a horizontal longitudinal axis below the barrel. There are two triggers, one for cocking and the other for firing, the hammer not being in sight.

157. Stevens's shotgun, 1864, 13 bore.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. Barrel rotates on horizontal axis about 3 inches from breech, and extractor on under side of barrel is worked when the breech of the barrel is thrown up.

158. Wesson breech-loading rifle carbine, caliber .40, 1855, metallic cartridge.—The rear of barrel tilts up for loading, it being hinged to the stock below. When the charge is in, the barrel is depressed and held by a spring catch. To open the breech this catch is released by a second trigger in front of the trigger for lock; 151 of these guns were purchased by the United States Government for use in the civil war.

159. Breech-loading rifle musket (unknown), 1863, caliber .50.—Breechblock opened by hammer, closed by hand. By cocking the hammer a parallel projection on the shaft of the tumbler strikes against a hinged stud within the breechblock, first lifts it out of its seat in the receiver, and then draws it back until the breech is fully exposed. The hammer is stopped at the half-cock by a projection on the side of the breechblock, against which it strikes. The block is closed by hand. It is locked when in place by setting into its mortise or seat in the receiver. One remarkable feature, especially, considering its date, consists in the absence of screws, the entire breech mechanism, including the lock, having but one screw, and that one free from many objections of its kind.

160. Root's breech-loading carbine, lifting and sliding breech, caliber .50, 1867.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. Has a breechblock which is lifted slightly and then slides to the rear like a bolt. The extractor slides to the rear under the bolt, a lug on the bolt engaging it, when its motion is almost completed. The lock is adapted for rim-fire and there is a cocking hammer on the side.

161. Root and Lord's muzzle loader, converted to breechloader, caliber .58, 1868.—Loaned by Colt's Patent Fire-Arms Manufacturing Company. Has a lifting and sliding breechblock, the operations being done by hand. The ejector is drawn back by the block and the empty shell knocked out by a lever from below. Rim-fire.

162. Joslyn carbine, caliber .50.—Opens by turning block to the left. Extractor on block.

163. Warner's breech-loading carbine, caliber .50.—Metallic cartridge, brass frame. Breechblock hinged to right side and held down by a catch on the left side. The extractor is worked separately by a slide

underneath the barrel. Four thousand and one of these guns were purchased by the United States Government for use in the civil war.

164. Berdan's breech-loading carbine, breech swings sideways to the left, caliber .45, 1865.—Loaned by Colt's Patent Firearms Manufacturing Company. The breechblock has a longitudinal hinge on the left side and can only be opened when the gun is at a halfcock. The hammer is on the right side and strikes a plunger for rim fire. The extractor is pulled to the rear by hand. The barrel is round and the bore hexagonal. This gun fired a paper cartridge with brass rim and base. There is a tubular cavity in the butt for tools.

165. Collin's alteration of muzzle loader, caliber .58.—The breechblock is opened by liberating a spring catch on its right side and swinging it over to the left. The extractor slides under the well of the receiver and is moved by a separate trigger beneath the barrel. This trigger has a cogged section on its upper surface, which meshes into an intermediate pinion between itself and the cogged lower surface of the extractor. This causes a pull on the trigger to slide the extractor backward.

166. Austrian Werndl rifle, caliber .45, 1872, saber bayonet.—Fired by side lock. The breechblock swings on an axis below the line of the barrel, but parallel thereto, and it has a slot when rotated for the insertion of the ammunition. This is turned by means of a thumb piece. A spiral groove in the shaft serves to work the extractor.

167. Peabody breech-loading rifle, caliber .45.—This is the type gun of the class with breechblock hinged in rear and dropping in front to expose the cartridge chamber, and its principle is the foundation of the Martini-Henry. It is operated by depressing the guard lever, which is hinged in front and provided with a short arm extending up and engaging in a notch in the bottom of the block. The movement of this arm to the rear forces down the front end of the block. The nose of the block strikes the arm of an extractor hinged below and drives the cartridge shell back with force; closed by a reverse motion of the lever. When closed the block is held up by the short arm of the lever acting as a brace. This has a back-action side lock of usual pattern, with exterior hammer striking a curved firing pin running obliquely through the block. This arm was used extensively and effectively by the Turks in the recent Turko-Russian war.

168. Werder breech-loading rifle, Bavarian, caliber .45.—This has a falling breechblock hinged in rear like the Peabody. It is held up by an arm attached to a small lever in front of the trigger. Pressing this lever forward allows the front of breechblock to drop to open the breech. The hammer swings centrally in rear, and strikes a firing pin running lengthwise through the bolt. When the block is down, drawing back the hammer not only cocks it, but closes the breech by tilting up the block.

169. Lee gun, caliber .45, 1875, opened by pressing forward the hammer.—The breechblock in this gun and the next one is hinged in rear, falling in front like the Peabody, but the block is depressed and raised by pressure on the hammer, which is placed centrally in rear of the block and which acts on a longitudinal firing pin. In this piece, when the hammer is down, pressing forward on the hammer throws down the front of the block to the position of loading, where it is held by the lip of the extractor engaging over its forward end. Inserting the cartridge moves the extractor forward and lets the block move up under the action of an extension of the mainspring. The block is held up by a projection on the rear portion of the trigger.

170. Lee gun, caliber .45, 1875, opened by half cocking hammer.—A link, pivoted to the front end of the hammer piece, engages the under side of the block, so that drawing back the hammer to halfcock pulls down the block, which is held down, as described for Lee gun No. 62. The operation of closing is the same in the two guns. In both the motions of loading are greatly simplified. A still greater simplification of breech mechanism, devised by Col. J. M. Whittemore about the same time, provided for pulling the trigger before the breech was closed, the breech closing before the firing pin could strike the cartridge.

171. Martini-Henry rifle, caliber .45.—Very similar to the Peabody mechanism. Its main peculiarity consists in the concealed lock cocked by the depression of the lever in opening. An indicator on the right side serves to show the position of the "cock," and a sliding safety piece, also on the side, serves to secure the hammer. Has a long saber bayonet.

172. Five guns, showing modifications of the Remington system.—In this, the breech is closed by a block revolving backward on an axis below, perpendicular to barrel. A cylindrical shoulder at the base of the hammer in rear is made to support this block. The specimens show different modifications—Benton, Laidley, etc.—of the locking device, to give security from premature explosion or to render the opening easier. Twenty thousand guns of the Remington system were purchased by the United States Government for use in the civil war.

173. German Mauser rifle, caliber .45, 1870, for saber bayonet.—The breech action is similar to that of the later forms of needle gun, but the needle is abolished and a firing pin substituted, as the piece is used with central-fire metallic cartridges. An extractor, working in a slot in the left side of the shoe, is fastened to the bolt, projecting forward. The needle gun had been much improved before the change was made. The earlier ones required to be cocked by the hand before the bolt could be turned and drawn out. In later patterns the operation of turning the bolt cocks the piece. The nose of the bolt is held

from turning, and this steadies the striking mechanism. One great improvement shown in this bolt is the camming action obtained in turning the bolt at the end in closing and at the start in opening. This is obtained by having the top of housing beveled off to the right in front of the receiver so that a rib projecting forward along the bolt from the handle shall strike it and be guided by it. Besides giving greater power in starting the extraction of the cartridge, this makes the sliding and turning of the bolt practically one continuous movement. This improvement is attributed to B. B. Hotchkiss.

174. French gras rifle, caliber .433, model, 1874.—This is the development of the Chassepot, as adapted to the metallic cartridge. The rubber washer formerly used as gas check is therefore omitted as unnecessary, and a heavy extractor placed on the bolt. The camming action above described for the Mauser bolt is here secured by a groove at the right side of the bolt, curved up at the rear. A screw projecting into the receiver through the housing on that side enters this groove, acting to turn the bolt.

175. Pierie or Glisenti rifle.—This is a bolt gun, and the special peculiarity is that the trigger extends to the rear of the bolt, so as to be operated by the thumb instead of the forefinger.

176. Van Choate's breech-loading rifle, caliber .45, 1869.—Loaned by Colt's Patent Fire Arms Manufacturing Company. A bolt gun with rotating handle, which engages lug for locking and taking the strain. The gun is cocked by withdrawal of bolt, and has also a second trigger for cocking.

177. Berdan's breech-loading rifle, caliber .42, Russian army, "Slam-bang."—Loaned by Colt's Patent Fire Arms Manufacturing Company. Has a rotating and sliding bolt. The extractor is on top, and it rotates with the head of the bolt. The lock has a full cock only, and cocking is performed by pushing bolt forward. Can also be cocked by hand. The bolt pushes way in and turns squarely down, with no screw motion forward, as in the Mauser and Chassepot guns.

178. Beaumont musket, Holland, caliber .45.—Presented to the United States by the Government of the Netherlands in 1872. A bolt gun. Cocked automatically by turning up the handle to open the breech. It operates otherwise very much as the Chassepot. This has a spiral spring. A safety catch on the right side of the receiver locks the bolt in place after loading, and permits the arm to be carried without danger either of accidental opening or of discharge.

179. Palmer carbine, caliber .50, 1865.—Bolt gun with side lock. Instead of being secured like an ordinary door bolt, as in the needle gun and Chassepot, the bolt has a sectional screw at the rear end, engaging, when turned, with corresponding screw sections in the receiver. Essentially the same as the "French breech screw" described under 3.2-inch rifle. Rim-fire cartridge. Spring extractor

lying on bolt and fastened to it. The bolt revolves independent of extractor. Ejection accomplished by a side lever thrown outward by a spring as the shell passes it. Fired by ordinary side lock, the hammer striking cartridge directly on rim. One thousand and one of these arms were purchased for use of Army during the civil war.

180. Lindner's breech-loading rifle, caliber .537, Austrian, metallic cartridge, 1867.—Loaned by Colt's Patent Fire Arms Manufacturing Company. Same method of securing bolt, with a side hammer for striking firing pin. Rim fire. The bolt has an extractor on its lower surface traveling in a groove in the bottom of the receiver.

181. Ward Burton rifle, caliber .50, model, 1870, alteration of muzzle-loading Springfield.—Same method as above of securing bolt. Lock concealed in bolt. Self-cocking by operation of loading. Ejector, a pin driven out of front face of bolt when well back. Issued for experimental trial in the field with the Springfield Remington and Sharp's arms. One thousand of each.

182. Berdan's breech-loading carbine, breechblock swinging up on front hinge, caliber .42, 1869.—Loaned by Colt's Patent Fire Arms Manufacturing Company. This gun has a breechblock and extractor very similar to the Springfield rifle. The breechblock has a firing pin extending only part way to the rear, and for the remaining distance the block is counterbored to admit the striker, which acts axially in extention of the barrel to the rear. The mechanism has a half and full cock, but the block can only be opened when the gun is at full cock. Adopted by Russia.

183. Russian Berdan breech-loading rifle, with bayonet, caliber .42, 1870.—Similar to the above.

184. Braendlin Albini rifle, caliber .45, 1868.—Presented by Belgian minister. The breechblock is hinged in front at top of barrel as in Springfield breechloader. It is locked in place when closed by a bolt connected with a hammer, which entered an axial cavity in the block. The firing pin lies forward of this cavity, and is struck by the bolt when the hammer falls. Opening the breechblock operates a double extractor, which is without an accelerating device. This arm is used by the line of the Belgian army. The first Berdan rifle adopted by the Russian Government is a combination of the Braendlin Albini and the Chassepot. The lock is in line of barrel, and it is worked by a spiral spring. Berdan's later model is a bolt gun. He also invented a double-jointed block, which is claimed to be the basis of the present Springfield model.

185. Austrian Womzel rifle, caliber .54, 1870.—Action similar to that of Braendlin Albini. By cocking the hammer a bolt attached to the tumbler is drawn back from its cavity in the body of the breechblock. The breechblock is then raised by the handle on its right. The bolt above referred to locks down the breechblock against the strain of the

discharge. The extractor slides along the side of the receiver, being connected with a projection on one of the hinge pieces of the breechblock forward of the joint. The projection is cam-shaped, and bears against a flat spring on the side of the receiver. This spring tends to keep the breechblock open until forcibly shut. The hammer strikes a special firing pin, traversing the block diagonally to the lowest point on the face of the breechblock. The cleaning implements accompany this piece.

186. Swiss Millbank Ansler, caliber .45, 1870.—Essentially like the Springfield rifle, the cam latch in the gun stretching across the full width of the receiver. Browned barrel and mountings. It has no spring. There is no ejecting device. The hammer has no half-cock.

187. Springfield rifle musket, caliber .50, model 1862.—Altered on Allin's plan. Leaf spring ejector stud. Five thousand of these guns were made in 1865, as soon as the return of peace permitted the attention of the Ordnance Department to be directed from the question of the immediate supply of the most easily manufactured arms. The arm is the first of the series of alterations of the muzzle-loading rifle musket which have developed into the Springfield rifle, caliber .45, of the present day. It is opened by raising the cam latch by means of the thumb piece, as at present, fired by a side lock in the same way. It differs from the present gun mainly in the detail of its parts, and in the extractor. This slides back and forth in a groove cut in the side of the barrel. Upon its upper edge it bears a rack, into which meshes a series of similar teeth in a curved arm running up from the front of the breechblock. A spring serves to draw it back. The objection to this arrangement was its delicacy, and the liability of the stock to being blown away through the cut made for the extractor, in case the cartridge head should burst.

188. Millbank's alteration of Springfield muzzle-loader, caliber .58, model 1866.—Block on side hinged in front, swings to the right and forward. Block is locked by point of hammer.

189. Miller's alteration of Springfield muzzle-loader, caliber .58, model 1866.—The breechblock, which is hinged above the barrel, is made with an L-shaped arm covering the mouth of the chamber, and provided with a tenon entering a mortise in the bottom of the receiver. This mortise is a little longer than the tenon, and receives the lower end of a vertical bolt sliding in the back surface of the breechblock. When this bolt is down, the mortise is filled and the breech can not be opened. When it is lifted, sufficient space is given for the tenon to clear the end of the mortise in opening. A spring tends to keep the bolt always down. A projecting arm at its forward end moves a sliding extractor in the side of the barrel.

190. Springfield rifle musket, caliber .50, model 1866.—Differs from Allin's alteration in the greatest strength of its parts, and in the

extractor, which consists of a U-shaped spring against the side of the receiver. One point of this spring projects into the receiver and catches against the rim of the cartridge as the cartridge is passed into the chamber. Closing the breechblock compresses this spring, which is released on opening with sufficient force to throw out the empty shell. The caliber of this barrel is reduced from .58 to .50 by the insertion and brazing of a lining tube.

191. Springfield rifle musket, caliber .50, model 1868.—The main point of the improvement over the last arm consists in the use of a separate receiver for the barrel and parts of the mechanism, and in the improvement of the extractor, which is the same as that now employed, a lever turning on hinge pin and started positively by the block, the motion being completed by an ejector spring acting on the extractor.

192. Springfield rifle musket, caliber .50, model 1870, E. S. Allin's improved center lock.—The essential feature of this consists in its dispensing with the number of parts forming the ordinary side lock. The mainspring in this case lies under the receiver. The other parts lie beneath the tang of the breech screw.

193. Springfield rifle "Officer's" model, 1873, caliber .45.—Detachable pistol grip, checked stock, peep and globe sight.

194. Springfield "Marksman's" rifle, model 1873, caliber .45.—Pistol grip, peep and globe sight, covered front sight with level attached.

195. Twenty Springfield carbines, service model, 1884, caliber .42, Buffington sight.—A description of this sight is given later on.

196. Twenty Springfield rifles, service model, 1884, caliber .42, with Buffington sight.

197. Two Springfield rifles, with ramrod bayonets, one bayonet round, latest model, 1886, the other triangular, 1873.—See Hall's carbine for note of very early form of ramrod bayonet. The rod fits in the ramrod groove, and when slipped forward to serve as bayonet it is held by spring catches.

198. Springfield long-barrel carbine, new model, caliber .45, experimental, 1887.—Barrel 24 inches long. Stock runs nearly whole length of barrel. Has no lower band. Buffington sight.

199 Springfield breech-loading shotgun, model 1881, 20 bore.—This is a single-barrel gun. Two are issued to each company in service, for hunting purposes.

200 Kelton's hammerless Springfield rifle, model 1887.—In this model the lock is concealed in the breechblock. Opening the block compresses the firing spring by means of a side lever and arm. The sear projects below the block and catches in the trigger. For note of another hammerless device, see Clemens's magazine Springfield gun, under head of "Repeating arms."

201. Springfield rifle, caliber .45, trowel bayonet.

202. Springfield rifle, caliber .30, model 1891.—This is an experi-

mental gun made for trial in competition with the magazine guns tried before the army board in 1892. The special peculiarity in the breech mechanism consists in the action of the locking cam of breechblock. Instead of simply turning in its seat it has also a slight lateral motion, the surface of cam and seat being tapered, so that the cam is set up more closely in the seat, giving less danger of accidental opening.

MACHINERY USED IN THE MANUFACTURE OF SPRINGFIELD BREECH-LOADING RIFLES, CALIBER .45.

This is conducted by workmen specially detailed for this purpose. It was manifestly impossible to transfer to the exhibition the entire plant of the armory, and only representative machines were selected for the display. In this manufacture are shown types of every process used in gun manufacture, many of them originating in the armory workshops. The United States national armory at Springfield, Mass., was first set in operation in 1794. Its production during the recent civil war was at one time 1,000 new muzzle-loading rifled muskets per day of twenty-four hours, employing about 3,000 men, at a cost of about $12 per musket. Its capacity for breech-loading rifles has not since been tested to extremes.

The successful development of the interchangeable system of parts in the manufacture of firearms was first made at United States arsenals. Attempts had been made as early as 1717 in France, but they were abandoned in 1732 as impracticable; again taken up in 1785 by Gribeauval, they were abandoned after a trial of ten years. In 1792 a lathe was used in France to turn the exterior of barrels, except the flats, which had to be filed. In 1816 Blanchard, at the Springfield Armory, introduced lathes for turning the barrels, flats and all. In 1817 Hall, at Harpers Ferry arsenal, succeeded in making his breech-loading gun with parts interchangeable. Eli Whitney had previously used this method for certain parts.

In 1820 Blanchard, at Springfield Armory, introduced his lathe for turning stocks with a guide for the cutters. As late as 1862 English Enfield arms bought for use in this country were lacking in interchangeability of parts, even the bayonets being specially fitted to particular guns. The gun-making and cartridge-making machinery of the United States has been copied by all nations.

Most of the machines shown here were adapted to making the .45 caliber Springfield rifle, as the manufacture of the new small-caliber rifle was not sufficiently advanced to exhibit it and the method used on the same. The only machine in this exhibit for the new gun is that for drilling the barrels. The preparations for the manufacture of the new arm were begun at the armory in September, 1892. Such a change of manufacture in an establishment of the magnitude of the Springfield Armory always involves an immense amount of detail and study

in developing the best methods of making each component piece of the arm, of performing the operations upon each piece, of arranging the tools and fixtures for these operations, and, finally, in preparing the large number of gauges needed to verify the correctness of the work and secure interchangeability of parts. The total number of parts in the .45 caliber Springfield rod-bayonet rifle is eighty-four, and in the manufacture of that arm, omitting the stock, there were employed 449 "fixtures" and 1,097 "gauges." The new magazine rifle has 88 parts, or four more than the .45 caliber Springfield single loader. The manufacture of the .45 caliber rifle was brought to a close during the month of June, with the termination of the fiscal year.

All this machinery, including that for cartridge making and the testing machines, was driven by a 25-horsepower Edison electric motor placed under the floor, and run by electricity supplied by the Exposition.

396. Stock turning, Blanchard lathe for turning irregular forms.— This machine was devised by Thomas Blanchard and James Stillman, employees of the national armory, Springfield, Mass., in about 1820. The original machine obtained from the armory stands near the modern machine in the exhibit. It was the parent of a great variety of similar machines used in turning spokes, ax handles, shoe lasts, etc., which have been of inestimable benefit to American manufacturers, and the guide principle used in it is followed in profiling and bedding machines described below.

The stock, having been sawed, centered, and roughly turned at the tip, is brought to this machine, being set by the center marks in the butt, the tip being passed through a revolving holder and clamped. A little below the part to be turned and parallel to it is placed an iron pattern called the "former" (see profiling machine No. 405), and made of the shape of the finished stock. Rising behind the "former" and the rough stock is a rocker lever, the lower end of which, near the floor, is traversed by a shaft running the length of the machine. This permits it to swing back and forth at right angles to the work, which, with the former, has a motion of translation in the direction of the length of the machine. The rocker carries near its upper end two wheels of equal diameter, one a blank wheel of iron called the "guide-wheel," resting against the iron "former;" the other, consisting of several spokes armed at their extremities with sharp steel cutters, occupying a similar position higher up against the wooden stock. The cutter wheel has an independent connection for giving it an extreme velocity of rotation. Now the function of the machine is clear. Being set in motion, the gun stock and former both move slowly about parallel axes and at the same time pass along in front of the revolving cutter and guide wheel. The "former," acting upon the guide wheel, throws the cutter above it out and in, according as the guide wheel happens to rest upon projections or retired points upon the surface of

the "former." The result is that the cutters follow the movements of the guide wheel, and, having also, as before described, a relative motion of translation along the stock, reduce it by a long spiral cut to the form desired. This operation is repeated in the finish turning which, making a fine and narrower groove, leaves less prominent ribs to be scraped off by hand by the finishers. The operation of turning the tip, before referred to, is conducted in the same way, and it was therefore omitted from the exhibit, the operation shown being of greater interest on account of the great irregularity of the butt portion of the stock.

397. Barrel-bedding machine.—For cutting out the groove for the barrel in the stock. This is a complicated machine with many cutters. The stock is held horizontally on a platform, and the flat surface in which the groove is to be cut is uppermost, the platform having a sliding motion lengthwise of the stock. Vertical revolving cutters are fastened above to a transverse rack, having a horizontal sliding motion across the stock. One cutter after another is brought over the stock and lowered to position, and the stock is moved lengthwise under it until the proper cut is made or the desired holes bored. To finish smoothing the groove a horizontal revolving cutter is used, fastened to the end of an arm hinged on a ball and socket joint to the table in prolongation of the small end of the stock, and projecting along the stock. The stock is run forward under this cutter, and by means of a treadle the workman rocks the cutter back and forth in the groove. This operation over the stock is run under another cutter, turning about a horizontal axis, and the end of the groove is squared up for the breech of the barrel.

Of special note in the bedding machines, this and those described below, is the arrangement for shifting belts to and from the pulleys of the different cutters, so that only the cutter to be used is in motion.

398. Stock-planing machine.—For facing off the outlines of the stock to fit in the lock-bedding and guard-bedding machines. The stock, resting on a guide plate hinged to swing and slide horizontally on a table, is brought in contact with rapidly revolving vertical cutters, the edges of the guide plate serving to keep the stock at the proper distance from the cutter.

399. Lock-bedding machine.—For cutting out the seat of the lock in the gunstock. This operates precisely upon the principle of the profiling machine before described. The only essential difference being that in this case, on account of the greater variety in the diameters of the holes and curves to be produced, and the consequently increased number of cutters and guide pins, the latter are arranged upon a reel instead of side by side, as in the profiler, so as to save room. The arrangement for automatically shifting the belt on and off the spindle is especially interesting. Cost, $1,900. Use, bedding gunlocks. Made by Ames Manufacturing Company, Chicopee, Mass.

400. Guard-bedding machine.—For cutting out the seat of the guard plate in the stock. This operates in a similar way to that for lock bedding, but fewer cutters are needed, and a rocking motion is given to the stock as it moves lengthwise, so that the cut will follow the curve of the stock where the guard plate is to rest.

401. Assembling bench.—Designed to illustrate the manner of assembling or putting together the component parts of the Springfield breech-loading rifle, caliber .45; also to manifest the complete interchangeability of its parts.

402. Drop hammer.—The hammer, weighing 400 pounds, is raised by means of the "belt-board," a narrow board fastened to the top of the weight, and passing between two rollers at the upper end of the ways. These rollers revolve in opposite directions, and ordinarily without touching the board. By means of a treadle the rollers are brought together, and, pinching the board between them, they raise the hammer to the required height. It may be held there by a pawl upon one of the ways and dropped with a fixed blow, or may be let fall from an intermediate point with a varying blow. The other principal features of this machine are the solid ways, with their adjustment for wear, and the continuous treadle. This machine represents the operation of breaking down or shaping, forging, or bending, hammers, butt plates, and side-screw washers. Lead is used for this purpose in the exhibit, instead of bars of hot iron and steel, used at the armory. Loaned by Merrill Brothers, Brooklyn, N. Y.

403. Milling machines.—The revolving "mills" are provided with teeth which, as they turn, cut upon the work a profile matching their own. By suitable connections the work is gradually drawn beneath them and this profile indefinitely repeated across the area of the whole piece. Thus a cylindrical mill cuts a plane surface, as seen in the machine-milling lock plate. A barrel-shaped mill cuts a hollow surface whose elements are straight lines at right angles to the axis of the mill. By combining cutters of different form upon the same shaft a great variety of surfaces can be cut. Even this arrangement is varied, however, in the two machines engaged in milling curved butt plates. Here, in order to suit the wavy form of the line of the plate, and to turn the corner at the junction of the sole and the tang, a reciprocating motion is given to the fixture holding the butt plate as it goes under the mill. The fixture holding the work is hinged at its forward end on a horizontal axis. Beneath the upper flap so formed, and fastened to it, is a web cut out to correspond to the line of the butt plate. As this web moves on it passes over a stationary cross-bar, which causes both the web and the butt plate above it to rise or fall under the mill according as the web projects or is cut away. This is called a bridge-milling fixture. The work is gradually carried under the mill by a screw motion, which stops automatically as soon as the cut is completed. The work is then rapidly withdrawn by

hand. A similar rocking movement is seen in the machine for bedding stock for guard plate. Cost, $270 each. Works upon butt plates, receivers, hinges, pins, washers, lock plates, etc. Made by Ames Manufacturing Company, Chicopee, Mass. Specimen boards show all the shapes milled in making the .45-caliber Springfield rifle, with the cutters therefor.

404. Clamp milling machine.—For cutting out irregular forms of a circular cross section whose axis is a straight line. For this work generally a wire or a blank screw is clamped firmly in a holder connected with the headstock, and this is made to revolve between a pair of stationary jaws provided with longitudinal teeth, and formed so as to partly inclose the work. The file of the jaws corresponds with the form desired to be given to the piece. Cost, $270. Used in making the firing-pin, head of the ramrod, circumferential grooves in end of ramrod, mill forged butt-plate screws preparatory to cutting thread, etc. Made by R. Hoe & Co., New York and Boston.

405. Profiling machine (sometimes called edging-machine).—This works on the guide principle illustrated in the Blanchard lathe for turning irregular form. Its use is to edge off pieces of irregular form. These pieces are laid flat and clamped in place on a horizontal platform, having a sliding motion forward and back. Vertical revolving cutters made like the cutters of the milling machine project from an overhead frame, which has a sliding transverse motion, and the cutters are made to run around the edge of the piece, the cutters being guided by guide-pins which project downward parallel to the cutters from the overhead frame, these pins being made to follow the edges of a flat stud pattern or "former" fixed to the table by the side of the "work." The pins can be lowered so that the guide-pin will enter the "former," and when in position a catch upon the frame keeps them from rising. Having set the cutters in motion, they are brought against the work at any desired point by means of the two handles on the table, one of these handles giving a longitudinal motion to the fixture holding the work, and the other handle giving a transverse motion to the frame to which the cutter and guide-pins are fastened. The perfect parallelism of motion thus obtained between the cutter and its guide-pin secures a perfect reproduction of the former. The second cutter and guide-pin are employed to finish the cut roughed out by the first pair. The guide-pins are made taper at the portion in contact with the "former," so that by driving them in or drawing them back the cutter may be adjusted so as to trim off less or more of the work. Cost, $545. Works upon lock and butt-plates, hinge-pin. Made by Wood & Light, Worcester, Mass.

406. Barrel-turning lathe, second turning.—Resembles an ordinary engine lathe except in the following points: The turning tool is made to approach and recede from the center of the barrel, so as to give it

its form by means of a tapered slide upon which the outer end of the slide-rest travels. Opposite the high part of this guide the tool is thrown in toward the center; at the low point it is drawn back from it. The progress of the slide-rest, when the end of the barrel is reached, throws out of gear a clutch upon the head of the lathe and brings the operation automatically to a close. For the first turning the barrel is supported by a rest at its middle point. At this point upon the barrel is cast a ring of Babbitt metal truned off from the center of the bore. The barrel is second-turned without the use of this ring, as in this case, but a light chip is removed. A can, fastened to the slide rest, travels with and keeps a stream of water constantly running upon the tool. Cost, $440; use, turning barrels. Made at United States Armory, Springfield, Mass.

407. Barrel-drilling machine.—This machine marks a decided change in the manufacture of the gun barrel, rendered necessary by the adoption of a very small caliber. It is used for the caliber .30 barrel, in which it is necessary to drill a small hole through the entire length of the barrel. The special peculiarity of the machine lies in the drill, which is a twist drill perforated throughout its length by a hole through which oil is pumped to the point, this oil forcing back the chips of steel through a channel in the side of the drill; but for this a drill would clog in the long hole of such small diameter. The drill is held from turning, and it has only a sliding motion forward to press it against the revolving barrel piece to be drilled. This machine was made by Pratt & Whitney. In making steel barrels of larger caliber the cylinder of steel used was bored through before it was rolled to full length, and a mandrel inserted in the hole was held at the point under the rolls, preventing the reduction of the hole; but the new bore is so small that this method is impracticable, since such a small mandrel would become quickly heated in the hot barrel prepared for rolling. The barrels are therefore rolled out solid to full length and then drilled as described.

408. Straightening stand.—Inasmuch as the operations of boring, etc., are apt to leave the bore not absolutely cylindrical, it is straightened by laying the barrel across the two blocks on the anvil belonging to the stand and rapping it with a hammer. The irregularity of the bore is ascertained by looking through it at a horizontal line upon a ground glass shade, turning the barrel meanwhile upon its own axis. The image of this line is reflected upon the polished sides of the bore, in straight converging lines, if the bore be true. If not true, a wave is observed at the crooked point, which is rendered more evident by the revolution of the barrel. The straightening has all to be done before the barrel is rifled; after that the grooves interfere with the clearness of the lines.

409. Rifling machine.—The three cutters are arranged in slots at

equal distances apart around the head of the hollow rifling rod, which is made to reciprocate longitudinally through the barrel by means of an endless chain connected with the driving pulley. A transverse rotary motion is also given by means of a rack attached to the side of the frame. The combination of these two motions produces the spiral twist or rifling. In order to produce uniformity in the cut at each stroke of the rifling rod, the bell-crank lever on the side causes the barrel to make one-third revolution. This brings each one of the three cutters successively into every one of the three grooves. As the rod moves forward a projection on the ways strikes against a sliding transverse arm upon the carriage which carries a pawl and causes it to give a partial revolution to a toothed wheel at the end of the rifling rod. This wheel is connected with a spindle running longitudinally through the rod, having a conical termination at its further end, just beneath the cutters on the rifling head. (A sectional specimen is shown with rifling machine.) As this wheel revolves it pushes the conical head farther in under the cutters and forces them out slightly so as to deepen their cut in the barrel. As the rifling tool emerges from the barrel it passes through a jet of oil forced up by a pump attached to the driving pulley, which effectually washes off the chips and lubricates it for a fresh stroke. The oil runs back and is used over and over again. Twist, one turn in 22 inches. Made by R. Hoe & Co., New York and Boston. Cost, $1,100. Use, rifling barrels of caliber .45 rifle.

410. Engine lathe.—An ordinary engine lathe used in making repairs to tools, fixtures, etc. Cost, $320. Used in making and repairing of tools.

411. Cumming portable forge, with hand blower.—This consists of a circular wrought-iron basin connected by a wrought-iron pipe with a small revolving hand blower in the rear, and supported upon legs of gas pipe. The whole varies in weight from 90 to 220 pounds, according to model, and is readily separated into parts and packed in small space. The blower furnishes a strong and continuous blast by an occasional turn of the crank. There are no chains, belts, or bellows, and all running parts are protected from dirt and damage by a gear cover. Loaned by David Cumming, 30 North Desplaines street, Chicago, and used to great advantage for blacksmith work and repairs.

412. Polishing stand.—The "buff wheels" are made of wood, covered with a tire of leather secured by pegs. The leather is coated with glue and rolled in powdered emery or corundum. Used in polishing various components of arms, many varieties of wheels being used. Works upon butt plates and bayonets. Made at United States Armory, Springfield, Mass.

413. Rotary filing machine.—For smoothing out the interior of the "receiver" of the Springfield rifle. A roughened steel cylinder or file is revolved rapidly around a longitudinal axis, the file projecting from

the end of the shaft, and the tubular piece to be smoothed is pushed on over the file.

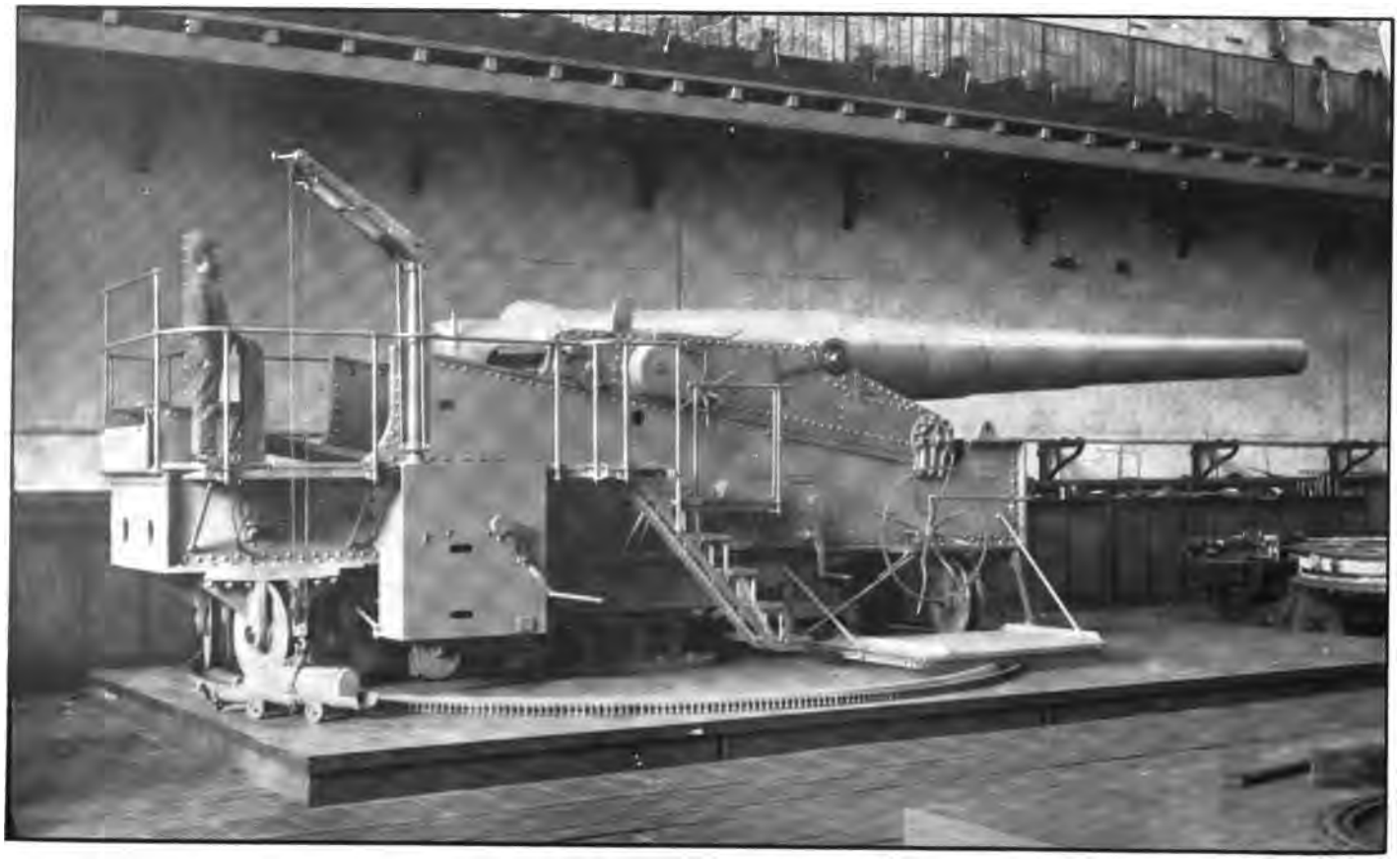
114. Emery grinder.—Consists of a spindle revolving at a very high velocity, upon which are fastened wheel. composed of emery, or corundum, and glue pressed up in a mold. Used in grinding the edges of all sorts of cutting tools, particularly for the mills, the true cylindricity of which is preserved by their being held during the grinding on an arbor upon which they revolve. This special feature is not represented on this machine. Made at United States Armory, Springfield, Mass. Use, grinding cutters.

KRUPP EXHIBIT.

BY

W. C. DODGE.

NO. 1.—16.54-INCH COAST GUN.



NO. 2.—11-INCH COAST GUN L/40 C/89.

KRUPP EXHIBIT.

By W. C. Dodge.

This exhibit is remarkable for its extent and the variety of guns exhibited, ranging from the largest and most powerful gun in existence to the smallest capable of being transported by men, thus providing for every conceivable military condition. The special points of excellence are quality of material, excellence of workmanship, proportion of parts by which the several guns are adapted to the special service for which they are designed, and their effectiveness, as shown by the diagrams and tables exhibiting their ballistic qualities. The following is a brief description of the several guns composing the exhibit:

LARGE COAST GUN.

This is the largest gun in existence, its weight being 120.46 tons, length 45.93 feet, length of bore 41.66 feet, caliber 16.54 inches, number of grooves 120. Its barrel is a jacketed built-up tube of special gun steel, with Krupp's round-edged breech closure, with traversing screw, steel ring and plate obturater, and fired by friction fuse.

It is mounted on a front pivot carriage with mechanism for lateral adjustment, the gun being elevated by toothed gearing, operated by hand wheels. The recoil is regulated by hydraulic brakes, the gun carriage being run out by a chain windlass. Maximum elevation 10½ degrees, depression 4 degrees. It has a crane for lifting shot, with ram, draw ropes, and windlass for loading. It fires cast-iron fuse shells, steel ditto, steel armor shells, and steel shrapnels, weighing from 2204.6 to 2513.2 pounds. Bursting charges from 22.04 to 143.29 pounds. Powder charge 903.89 pounds. Maximum penetration of wrought iron 3.53 feet near the muzzle, 3.26 feet at 1,000 yards, and 3.01 feet at 2,000 yards. Initial velocity 1,981.6 feet. It has been fired 16 shots. The workmanship is fine and, taken as a whole, it is undoubtedly the most superb piece of ordnance ever produced.

11-INCH COAST GUN.

This is similar to the preceding gun in construction, but has a length of 40 calibers while the other is 35. Length, 36.75 inches; length of bore, 33.99 inches; weight, 42.62 tons; 84 grooves. It is mounted on a coast carriage and arranged for an elevation of 45 degrees. The ver-

tical elevation is accomplished by hydraulic pressure operating on the rear portion of the slide which is journaled at its front end. The frame and turntable are connected and rest on a ring of balls, there being a stand on the turntable for the gun captain. This gun fires the four styles of shells similar to the preceding. Weight of loaded projectile, 760.59 pounds; bursting charge, 4.49 to 7.61 pounds; powder charge, 352.74 pounds; initial velocity, 2,067 feet; penetration of wrought iron, 2 feet 10 inches at muzzle; 2 feet 6.74 inches at 1,000 yards and 2 feet 3.58 inches at 2,000 yards.

9.45-INCH COAST GUN—CENTER-PIVOT CARRIAGE.

Construction of gun same as preceding. Caliber, 9.45 inches; length, 31 feet 6.13 inches, or 40 calibers; length of bore, 29 feet 1.75 inches; weight, 30.51 tons. Carriage center pivoted, with hydraulic recoil brakes located on outside of carriage in protected position, and so arranged as to permit an elevation of 44 degrees. A portion of the weight is supported on balls; lateral training by a pinion in a toothed ring on the base; vertical training by worm gear and a toothed arc. Minute training is effected by means of worm gear that can be thrown into or out of gear by the gun captain at will. The gun also fires the four styles of shells previously described. Weight of loaded projectile, 353 to 474 pounds; bursting charges from 3.53 to 26.4 pounds; powder charge, 92.7 to 254 pounds. Initial velocity, 2,100 feet to 2,623 feet; penetration of wrought iron, near the muzzle, 29.5 inches; at 1,094 yards, 26.5 inches; at 2,187 yards, 23.13 inches. The gun is remarkable for having made the longest range of any gun in the world with a projectile of the same weight, viz, 22,120 yards, or 12 miles and 1,000 yards. This was done April 28, 1892, at Krupp's practice grounds at Meppen, and is well illustrated in the accompanying diagram (p. 1301).

9.45-INCH FORTRESS AND SIEGE MORTAR.

This exhibit possesses the same merits as the guns previously described. The barrel is mounted on a plate carriage, resting on a fixed foundation with a center pivot, and without recoil. They are arranged for transportation by means of an axle with two wheels and a pole, or by the addition of a limber, as a four-wheeled vehicle. This and the other sized mortars and howitzers are designed to use projectiles corresponding in weight with those of the Krupp guns of same caliber. Length of barrel, 59.85 inches; length of bore, 47.24 inches; number of grooves, 28; weight, 1.72 tons; elevation, 60 degrees; initial velocity, 656 feet; range, 3,645 yards; penetration of soil, 7 feet 6.5 inches to 8 feet 2.4 inches, according to elevation, making funnel-shaped hole about 20-foot diameter at top. This mortar has been fired 266 times.

NO. 3.—9.45-INCH FORTRESS AND SIEGE MORTAR.

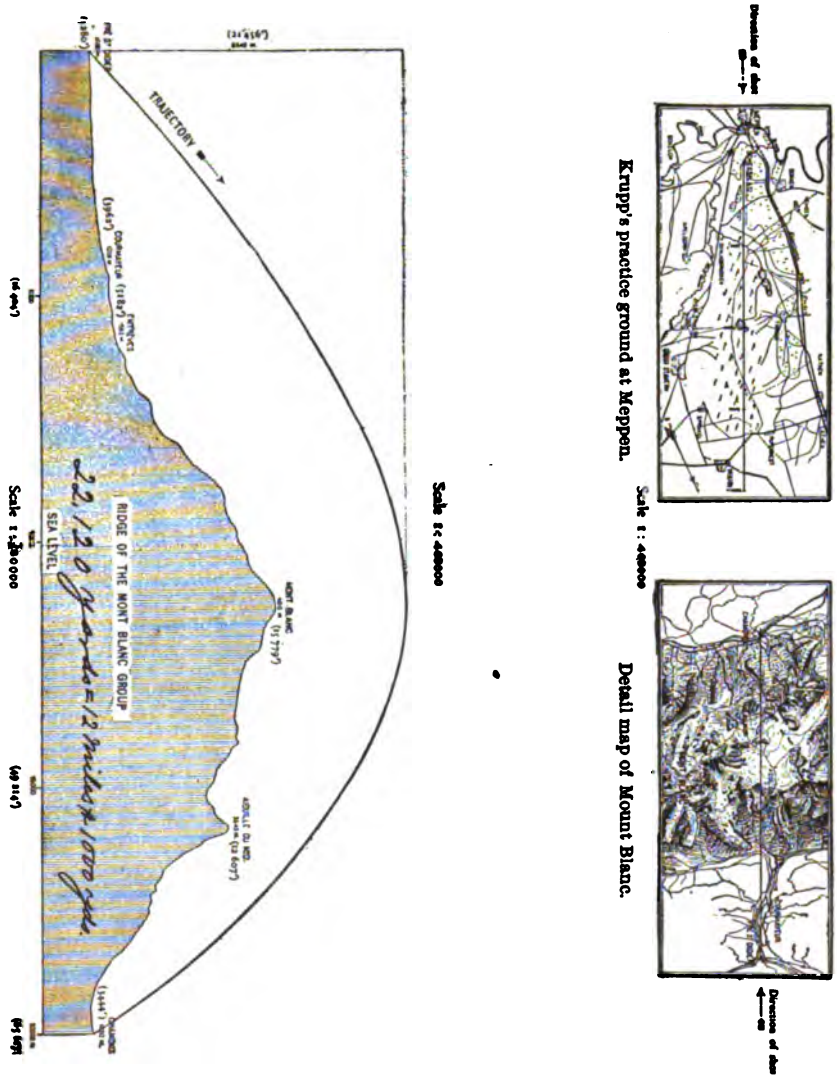
NO. 4.—9.45-INCH COAST GUN L/40 C/86 IN CENTER-PIVOT COAST CARRIAGE.

DRAFT

NO. 5.—4.13-INCH FORTRESS AND SIEGE GUN L/35 WITH CARRIAGE.

4.13-INCH FORTRESS AND SIEGE GUN.

The barrel is a jacketed tube 12 feet .088 inches long; bore, 11 feet .186 inches; caliber, 4.13 inches; 32 grooves; weight, 1,156 tons. Maximum elevation, 35 degrees; depression, 5 degrees; mounted on a wheeled carriage with brackets of plate steel; has double elevating



screw and hydraulic brakes for recoil. Gun fires cast-iron shells with fuze, steel shells with fuze, steel armor shells, steel shrapnels and case shots. Weight of projectile, 35.27 pounds, with bursting charge of 0.58 to 2.64 pounds; powder charge, 4.96 to 10.36 pounds; initial

velocity, 1,591 to 2,034 feet; penetration of iron near the muzzle, 9.84 inches; at 1,093 yards, 7.09 inches; at 2,187 yards, 5.12 inches. This exhibit has been fired with full charge 1,843 rounds, showing great power and endurance, rendering it a most valuable arm.

PORTABLE 2.95-INCH MORTAR.

This gun has a solid tube barrel with flat breech closure and removable crank. It is designed for use on rough ground wherever a vertical fire is desired, and is adapted to use the same ammunition as the mountain and field gun of same caliber. Length of barrel, 1 foot 6.89 inches; of bore, 1 foot 2.57 inches; caliber, 2.95 inches; 12 grooves; elevation, 45 degrees; depression, 25 degrees; weight of shells from 9.48 to 14.33 pounds, with bursting charge from 0.22 to 1.76 pounds; charge, 0.44 pounds; velocity, 524.6 feet to 656 feet; range at 45 degrees elevation, from 2,625 to 3,576 yards; weight of gun, 110.3 pounds; of carriage, 106 pounds. It can be transported and served by four men, rendering it specially useful in rough or broken regions, and should be considered in connection with the mountain gun.

2.95-INCH FIELD GUN.

The gun is constructed to use either a metallic cartridge or the ordinary bag cartridges. In using metallic shells the gun is provided with Krupp's quick-fire breech closure. When bag cartridges are used, and a more intense ignition is required, an extended igniting tube is used. With metallic shells, Krupp's fire lock or central firing obturating device is used. Length of barrel, 6 feet 10.68 inches; bore, 6 feet 28 inches; weight of barrel with breech closure, 683.42 pounds. Steel plate carriage, with automatic recoil brake, which also serves as a brake on the march. Elevation, 20 degrees; depression, 5 degrees; weight of limber, empty, 1,124.3 pounds; of equipment, 101.4 pounds; number of packed projectiles, 36; weight, 515.8 pounds; weight of projectile, 12.89 pounds; bursting charge, 0.198 to 0.308 pounds; powder charge, 1,124 pounds; initial velocity, 1,640 feet; range, 6,300 to 6,890 yards. The gun exhibited had been fired 322 shots, with excellent results, as shown by a table accompanying the exhibit.

2.95-INCH LIGHT FIELD GUN.

This gun is designed for use midway between the larger gun and the mountain gun. It has a jacketed tube, and is made with either the flat-wedge breech closure and obturating ring for loose ammunition or the quick-firing breech closure for metallic cartridges. Length of barrel, 5 feet 10.87 inches; of bore, 5 feet 5.55 inches; weight of gun, 518.09 pounds, and has 24 grooves. It is mounted on plate-steel carriage with wheels weighing 573.20 pounds; accessories, 11.02

NO. 6.—2.95-INCH AND 3.43-INCH MORTARS.

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NO. 7.—2.95-INCH FIELD GUN L/28.

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NO. 8.—2.95-INCH LIGHT FIELD GUN L/24.

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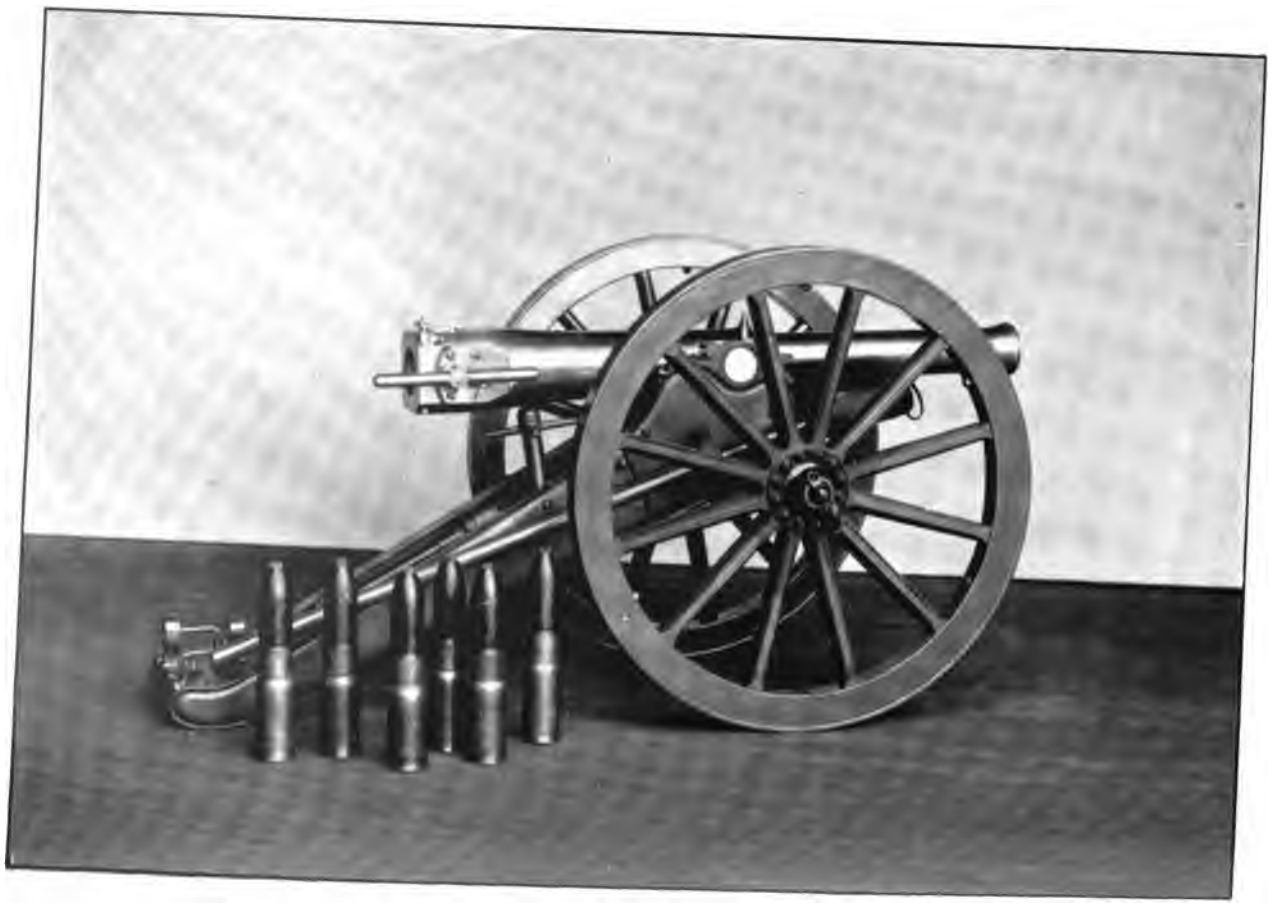
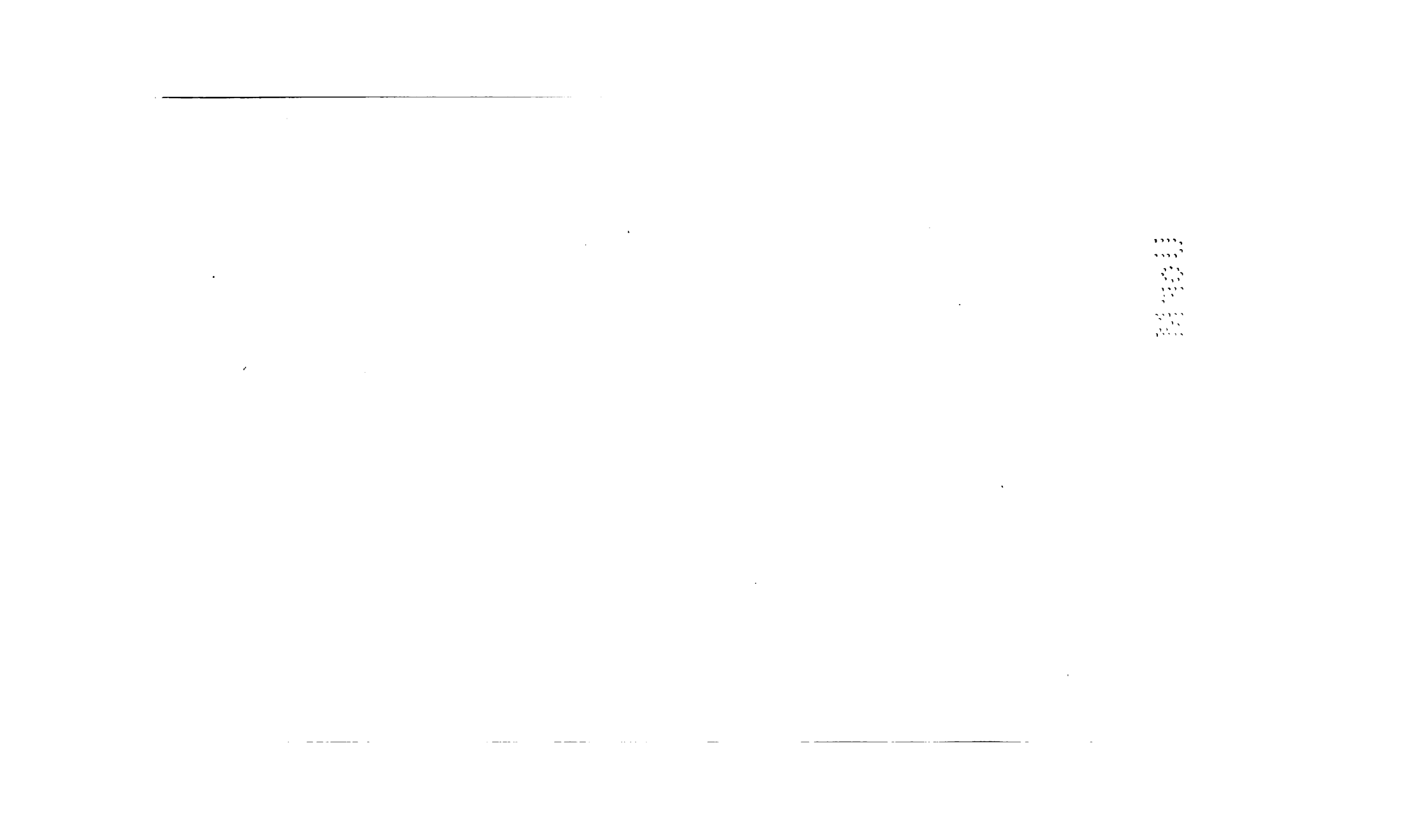
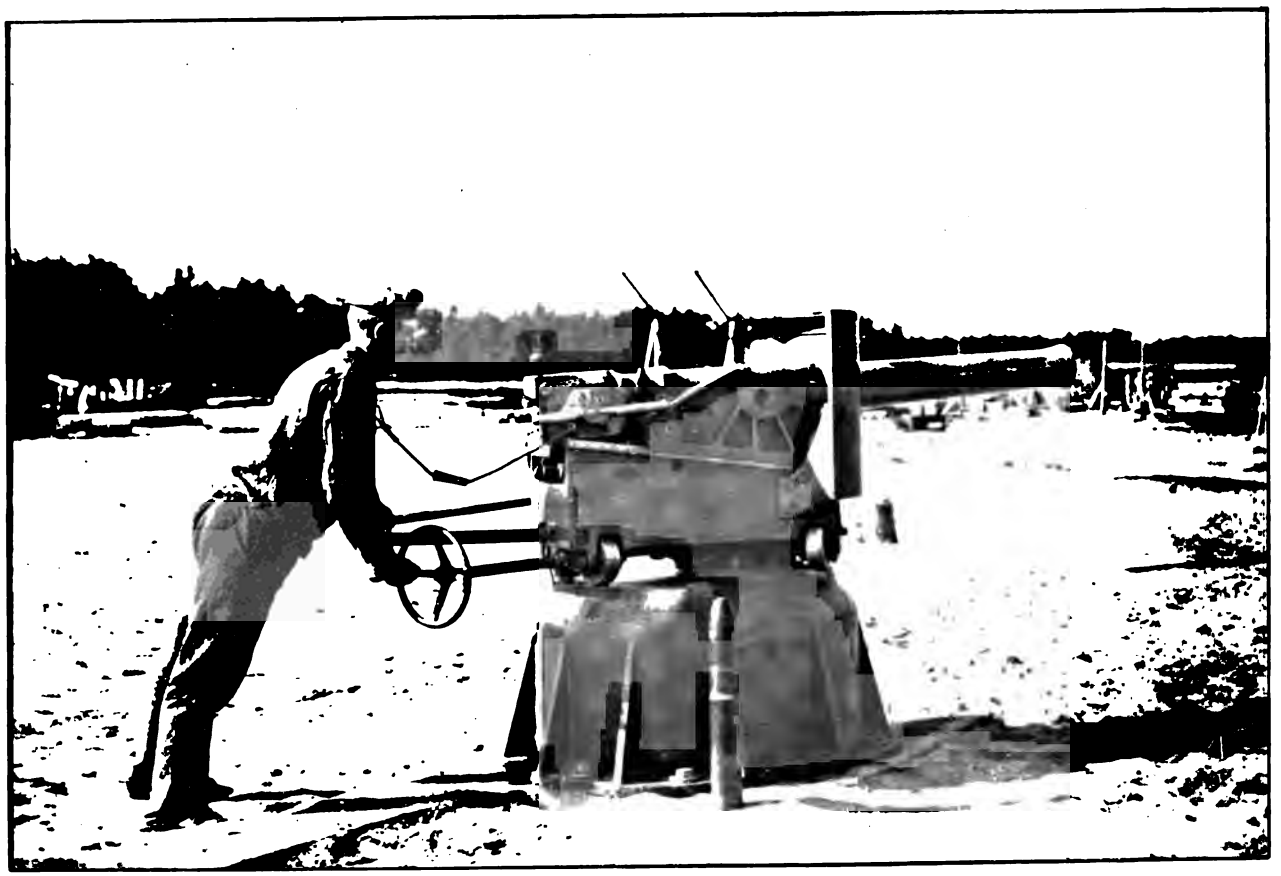
NO. 9.—2.95-INCH MOUNTAIN GUN L'13.



NO. 10.—2.36-INCH MOUNTAIN GUN.





NO. 11.—2.95-INCH QUICK-FIRING GUN L'25 IN CAPONNIER CARRIAGE.

pounds. It fires cast-iron shells, steel shrapnels, and cast shots. Weight of projectiles, 9.48 pounds; powder charge, 0.639 to 1,764 pounds; initial velocity 1,394 to 1,509 feet; range, 5,470 to 5,900 yards.

2.95-INCH MOUNTAIN GUN.

This gun is designed for use in mountainous and broken regions where wheeled vehicles can not be hauled, and the gun and its carriage are so constructed as to be carried by three pack animals. Length of barrel, 3 feet 2.38 inches; of bore, 2 feet 9.27 inches; weight of gun, 220.45 pounds; weight of carriage with wheels, 123.45 pounds; weight of ammunition box, 28.66 pounds; packed ammunition, 83.77 pounds; weight of projectile, 9.48 pounds; powder charge, 0.296 to 0.882 pounds; elevation, 20 degrees; depression, 10 degrees; range, 4,265 yards at 20 degrees elevation. Its great range and accuracy, as shown by accompanying diagrams of targets made, show it to be a remarkable gun considering its light weight. It can be transported by three mules when packed, or drawn by a single mule on an ordinary road.

2.36-INCH MOUNTAIN GUN.

This is a light gun intended for use in mountain districts with grape shot. Weight of gun, 198.41 pounds; of carriage with wheels, 198.41 pounds; total, 396.82 pounds. Length of barrel, 3.28 feet; of bore, 2.88 feet; caliber, 2.36 inches; elevation, 20 degrees; depression, 5 degrees; weight of projectile, 5.18 pounds; powder charge, 0.441 pound; initial velocity, 918.6 feet; range, 3,720 yards.

2.95-INCH QUICK-FIRING GUN.

The gun exhibited has a jacketed tube, with Krupp's quick-firing breech closure, with device for automatically firing on closing the breech. Length, 6 feet 1.82 inches; bore, 5 feet 6.14 inches; caliber, 2.95 inches; 28 grooves; weight, 0.315 ton; fires 40 shots per minute. The upper mount is of cast steel in one piece, mounted on rollers, with casing on left side for worm wheel of elevating apparatus which actuates a toothed arc on barrel. The frame is also of cast steel in single piece, has hydraulic brakes, is mounted on rollers, and permits training of gun to 150 degrees to each side, by means of worm gear. The frame is provided with a shoulder piece with a guard for protection from the ejected shells, and has scales for both vertical and lateral training of the gun. Elevation 6 degrees, depression 2 degrees, corresponding to loop hole or embrasure. Fires cast-iron fuse shells, cast-iron ring shells, steel shrapnels, and case shots. Powder charge, 1,323 pounds in a bag inserted in brass case, secured to projectile weighing 13.23 pounds; initial velocity, 1,640 feet; range, 4,156 yards.

1.46-INCH BUSH GUN.

This gun is designed for use where it is not practicable to use the mountain gun, and therefore has its several parts so proportioned that they can be transported by men. It has vertical breech closure, and uses brass cartridge shells. It is mounted on trunnions in plate-steel carriage, with pivot by which barrel can be rotated horizontally. Length of barrel, 4 feet .907 inch; weight, 88.18 pounds; weight of carriage complete, 101.41 pounds; weight of shell, 0.99 pound; powder charge, 0.154 pound.

2.4-INCH BOAT AND LANDING GUN.

This gun, designed for use in boats and for landing parties on shore, is mounted on a carriage, in a frame having a pivot and ball bearings; has limber connection also. Length of barrel, 4 feet .121 inch; of bore, 3 feet 8.29 inches; 24 grooves; weight of gun, 232 pounds; mounting, 611.4 pounds; carriage, 750.4 pounds; screw elevation, 15 degrees; depression, 3 degrees; weight of projectiles, 6.6 pounds; powder charge, 0.882 pound; velocity, 1,168 feet; range at 30 degrees elevation, 4,876 yards. The diagram of hits at target shows excellent results.

NO. 12.—1.46-INCH BUSH GUN.

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NO. 13.—2.4-INCH BOAT AND LANDING GUN L/21.

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ORCHIDS.

BY

F. SANDER.

1305

ORCHIDS.

By F. SANDER.

GROUP OF MISCELLANEOUS ORCHIDS SHOWN BY MESSRS. PITCHER AND MANDA, OF THE UNITED STATES NURSERIES, SHORTHILLS, N. J.

The exhibit in the great hall consists of 165 specimen orchids in good medium-sized plants and specimens well grown, in good health and condition. The largest specimens are:

Lælia purpurata. Fine variety; sepals and petals broad and flat; lip large and deep; colored; the specimen with about 80 bulbs; dark-green foliage, and well grown; 4 spikes of bloom.

Oncidium hastatum. Specimen in 15-inch pan with 5 flower spikes.

Lælia purpurata. In the way of Brysiana; very fine variety.

Cattleya mendelii. In 15-inch pan; variety in the way of Morgariæ, but rose-colored in sepals and petals; rosy purple blotch on lip; 5 spikes of flowers.

Cypripedium druryii. Fine specimen, having 5 growths; 2 flower spikes. A well-grown plant.

Lælia purpurata. In 9-inch pot; specimen with about 30 bulbs; variety good; plant well grown.

Cattleya massiæ. In 9-inch basket, with 22 bulbs; sepals and petals rose; broad, and good lip; light-colored, red center, and yellow veins and stripes.

Cattleya massiæ. With 28 bulbs; the variety very good; sepals and petals rosy; lip cream-colored, heavily fringed, broad; center dark rosy red.

Chysis bractescens. Specimen in 15-inch basket, having 26 bulbs and 2 flower spikes; the plant very compact and well formed

Cattleya massiæ. Specimen with 23 bulbs and 3 flower spikes; the variety has the lip marked in the way of aurorea; lip broad and well fringed.

Cattleya massiæ. Specimen in 8-inch pot; sepals and petals deep red; lip very fine dark crimson and heavily fringed; lower part of lip deep chocolate red; lip high up into the throat, marked with the same uniform color; good shaped and formed flower.

Cattleya massiæ. Three flower spikes; specimen in 9-inch basket; 4 flower spikes on the plant; sepals and petals dark rose; lip with deep center and edged white.

Brassia verrucosa. Specimen in 6-inch basket, the flower spikes carrying 8 flowers.

The collection also contains well-grown specimens of—

Aerides crispum.
Oncidium crispum.
28 plants of Epidendrum vitellinum.
Several Cattleya citrina.
Several Odontoglossum pescatorni.
Several Odontoglossum crispum.
60 plants of various sizes of Cattleya massiæ.

4 Lælia purpurata.
2 Lælia purpurata, smaller but fine varieties.
Odontoglossum odoratum.
Odontoglossum cordatum.
Oncidium superbiens.
12 plants of Cypripedium lawrenceanum in 6-inch pots.

Also the following Cypripediums in flower:

Cypripedium druryii.
Cypripedium selligerum.
Cypripedium swanianum.
Cypripedium supercileare.
Cypripedium ensigne maulei.
Cypripedium ciliolare.
Cypripedium barbatum majus.

The firm of Pitcher & Manda, Shorthills, N. J., have also large collections of orchids in the greenhouses in connection with the floricultural department, and these specimens will keep up the floral display of orchids during the season; in all, there are in the greenhouses about 1,500 plants and the varieties are as follows:

Cypripedium domirianum.
Cypripedium lawrenceanum.
Odontoglossum harryanum.
Cypripedium ciliolare.
Oncidium cucullatum.
Cypripedium superciliare.
Cattleya gigas.
Cypripedium parishii.
Cypripedium purpuratum.
Cypripedium harrisianum superbum.
Cypripedium albopurpureum.
Cypripedium calurum.
Dendrobium thyrsiflorum.
Oncidium papilio.
Oncidium kramerii.
Odontoglossum vexillarium.
Aerides fieldingii.
Odontoglossum citrosmum.
Aerides quinquevulnerum.
Aerides odoratum.
Vanda suavis.
Cattleya gigas sanderiana.
Cattleya massiæ.
Cattleya Trianæ.
Cattleya citrina.
Trichopilia tortilis.
Odontoglossum læve.
Chysis bractescens.
Oncidium pubes.
Dendrobium farmerii.

There are also in this collection several very large specimens of Cattleya flossiæ measuring some 2 and 3 feet in diameter and well furnished with sound bulbs and foliage.

Orchids exhibited by the New York State are displayed in the horticultural buildings erected by the exhibitors opposite the horticultural hall, and in all there are 125 well-grown specimens, some of them in bloom, and others ready to flower as the summer season advances. They promise a fine display, and to make the respective houses in which they are placed attractive. They are:

Laelia purpurata.
Oncidium cavendishiarum.
Laelia perennii.
Laelia anceps.
Laelia albida.
Laelia peduncularis.
Laelia autumnalis.
Oncidium papilio.
Laelia cinnabarina.
Epidendrum dichromum.
Laichopilia suavis.
Cattleya mendelii.
Epidendrum ciliare.
Cattleya percivaliana
Cattleya torbesii.
Brassavola glauca.
Epidendrum parkinsonianum.
Brassavola nodosa.
Cattleya speciosissima.
Miltonia clowesii.
Oncidium lanceanum.
Cattleya bowringnana.

Oncidium sphacelatum.
Miltonia clowesii.
Brassia verrucosa.
Cattleya trianæ.
Miltonia spectabile.
Cattleya holfordii.
Schomburghia undulata.
Cattleya imperialis.
Dendrobium pierardii.
Dendrobium thyrsiflorum.
Cattleya skinnerii.
Dendrobium nobile.
Cattleya crispa.
Schomburghia tibicinis.
Epidendrum nemorale.
Cattleya leopoldii.
Cattleya schilleriana.
Cattleya gigas.
125 plants in all.

Schomburghia tibicinis growing on native wood about 3 feet high.
1 block of mixed orchids about 2 feet high.
1 block 2 feet 6 inches high of Cattleya trianæ.
Cattleya speciosissima.
Epidendrum macrochilum.
Oncidium papilio.
Epidendrum prismatorocarpum.
Cattleya schroderæ.
Coelogyne pandurata.
Stanhopea tigrina.
Cattleya intermedia.
Oncidium jonesianum.
Oncidium trulliferum.
Oncidium sprucei.
Cattleya chocoensis.
Cattleya amethystoglossa.

There are also some 2,000 orchids imported and exhibited by the Mexican and Central American states. These specimens are partly very large and fine, and illustrate the way and manner in which orchids grow in their native homes. The quaintness of the form and shape of these exhibits attracts much attention from visitors, and is instructive and full of interest.

Many of the plants are in bloom, and quantities of the spider orchids (*Brassi verrucosa*) have produced flower spikes 3 and 4 feet long. These exhibits consist of—

Stanhopea.
Oncidium.
Epidendrum.
Laelia.
Odontoglossum.
Cattleya.
Chysis.
Brassavola.
Barkeria.
Lycaste.

EXHIBIT FROM NEW SOUTH WALES.

These consist of immense specimens Dendrobium speciosum, in all about 100 plants placed on tree stumps and tree tops, and displayed very advantageously. The plants have traveled well and are in the finest possible condition.

ORNITHOLOGY.

ORNITHOLOGY.

By Prof. ROBERT RIDGEWAY.

Although a large number of exhibits were carefully examined by me, cards were assigned me for only seven, which were as follows:

No. 122 F. State of Ohio (Columbus, Ohio). Birds of Ohio. Award recommended as illustrating the bird fauna of the State of Ohio. The specimens, as a rule, badly mounted, however, and a large proportion of them wrongly named.

No. 122 C. F. H. Lattin (Albion, N. Y.). Typical collection of North American birds, showing manner of nesting; birds' eggs; naturalists' supplies. Award recommended as an excellent exhibit of decorative taxidermy and naturalists' supplies, and a well selected and arranged collection of North American birds' eggs.

No. 125.—

No. 132 C.—

No. 132 G.—

No. 133 J.—

No. 134 *a*.—

It was in some respects unfortunate that the various ornithological exhibits at the Exposition were scattered about in the various buildings, often in out-of-the-way places. Perhaps a majority of the buildings contained at least one collection of birds, and in some of them (notably the anthropological and agricultural buildings) there were several. Being thus scattered about over the large area of the Exposition grounds, and many of them occupying very inconspicuous places among the bewildering array of surrounding objects, it became a difficult matter to discover them all, and possibly a few may have been overlooked. It was, for the same reason, impossible to make as close a study of the comparative merits of the several exhibits as could have been done were they nearer together, but, the awards being non-competitive, this was a matter of less importance.

The various collections of birds exhibited at the Exposition may be divided into three classes, as follows: (1) Scientific, (2) taxidermic or decorative, and (3) commercial. This classification is, necessarily, somewhat arbitrary, it being in the case of some exhibits difficult to decide to which category they should be referred. Under the head of "scientific" I would range all those exhibits which illustrate some sci-

entific idea or series of scientific facts. A collection consisting exclusively of the birds of any country would therefore be admissible to this category, since it illustrates in part the fauna of that country; and, in accordance with this view, I have recommended an award in the case of two exhibits which were manifestly of a partly commercial character. So, also, I would class as scientific the collection exhibited by Ward's Natural Science Establishment (Rochester, N. Y.), which, although consisting of a miscellaneous assortment of species from all parts of the world, was so effectively displayed and the specimens, as a rule, so well mounted and carefully labeled that it would be unjust to place it elsewhere. This collection of Professor Ward's, although intended for sale, and thus to a degree commercial in its nature, was, with the exception of the United States Government exhibits and that of the Illinoi. State Laboratory of Natural History, much the most important collectior of mounted birds shown at the Exposition. The specimens were several hundred in number, representing most of the families of the class *Aves*, were arranged in glass-fronted cases, and were carefully and for the most part accurately identified.

No other private exhibit of a scientific character was found worthy of mention; and as the governmental scientific exhibits require special and detailed description, notice of them is deferred until after an account of the minor scientific, taxidermic, and commercial exhibits.

The exhibits of bird taxidermy (artistic and otherwise—chiefly the latter) were numerous, but only a few of them were of sufficient importance to merit mention. Unquestionably the best was that of F. H. Lattin & Co. (Albion, N. Y.), in the anthropological building, which consisted of a considerable number of panels of game birds under convex glass covers, a small but choice collection of cabinet skins, a complete assortment of taxidermists' and collectors' supplies, and a series of nests and eggs of North American birds.

The exhibits of a purely commercial character were numerous and varied. Guatemala, Colombia, and other countries of Central and South America exhibited collections of their native birds in the form of unlabeled skins, such as find their way into the stocks of dealers in milliners' supplies, but usually not until such lots have been "culled" by one or more ornithologists. Two exhibits of this character, those of British Guiana and Guatemala, respectively, have, on account of their greater extent on the better quality of the specimens, been referred to the category of scientific exhibits.

In addition to these exhibits of a scientific-commercial character may be mentioned others which were strictly commercial, as the eiderdown robes from Norway, the ornamental feather work from Brazil and other tropical American countries and Florida, and the feather pictures from Mexico.

The various governmental exhibits, excepting those of the United

States Government and the State of Illinois, which, as previously stated, are reserved for special description, were those from the following countries and States:

Japan.—The agricultural bureau of the department of agriculture and commerce of Japan exhibited a very neat collection of "Japanese wild birds, useful and injurious, "consisting of about 130 specimens, representing 70 species. The specimens were mounted on neat wooden blocks with polished surface, on the edge of which was pasted a label giving the native and scientific names. Nearly all were fairly well mounted, some of them being really good examples of bird taxidermy. Unfortunately, they were not under cover, and were thus exposed to injury from dust and handling by visitors. The exhibit was explained by a neat printed pamphlet of 32 pages,[a] in which was given, in a concise form, full information regarding the character of each species, a sample of which is given below. The species are classified in this catalogue as follows:

I. The beneficial birds of forest and farm.

They are all insectivorous. As they catch and eat injurious insects, they are beneficial to forests and farms. [Then follows a list of species numbered from 1 to 21, inclusive.]

II. Birds which are used for food.

As in the case with the aquatic birds, such as Kamo, Sago, Shigi, and others, or with the gallinaceous birds, the flesh is delicious and can be used as food. They are called game birds in common language. [Nos. 22 to 56, inclusive.]

III. The birds for miscellaneous uses.

They are granivorous or omnivorous and are not beneficial to forests and farms. The flesh is not sold in markets, though it is not uneatable. In short, this group includes the birds which do not belong to the preceding groups. [Nos. 57 to 70, inclusive.]

Each of the 70 species is described separately in the following manner:

(1) ALAUDA JAPONICA, T. & S.

(HIBARI.) (SMALL JAPANESE SKY-LARK.)

Passeres.—Alaudidæ.

Where found.—It is a native of Japan and lives in the plains.

Characteristics.—Both sexes are alike in the color of the plumage. It sings loudly and can be heard at a great distance. It builds its nest among bushes and does not form in flocks. The flight is powerful. It ascends high in the air, flying round and round, and when it is tired it darts down and gets into bushes. Though it is omniverous, it feeds chiefly upon insects.

Utility.—It is kept in the cage and its flesh can be used as food.

New South Wales.—An unlabeled and badly mounted[b] collection of the birds of New South Wales was exhibited in the manufactures and

[a] A Descriptive Catalogue of Japanese Wild Birds, Useful and Injurious, Exhibited in the World's Columbian Exposition.

[b] It is but justice to state that these specimens were mounted in Chicago, lack of time preventing it from being done in Sydney.

liberal arts building, and a small lot of water birds from the same country in the fisheries building.

Dominion of Canada.—Canada sent two fairly good bird exhibits, the best being that from Ontario (in the anthropological building), which contain some examples of good taxidermy, among them a masterpiece in the shape of a captive great horned owl. The Manitoban exhibit (located in the Manitoban building outside the fair grounds), although larger than that from Ontario, was of less importance, the specimens being without labels.

Mexico.—The Comisión Geográfico Exploradora de México made an extensive and in many ways excellent exhibit of Mexican birds in the west gallery of the manufactures and liberal arts building. I discovered it casually, while looking for another exhibit. There was no one in charge of it at the time, and I was unable to inspect it again. I am, therefore, unable to give a fuller account of it, which I much regret, feeling sure that it was worthy of particular mention. The comisión, under the able supervision of Prof. Fernando Ferrari-Perez, chief of the natural-history section, made a notable exhibit at the New Orleans Exposition, in 1885, which was awarded the grand diploma of honor, and it is reasonable to suppose that, having the advantage of previous experience, their last exhibit would excel the first one.

Guatemala.—The Government of Guatemala exhibited a collection of several hundred native bird skins, comprising the commoner and some of the rarer species of that country. Most of these were unmounted and were placed in narrow bins covered with wire netting, and consequently exposed to dust and insects. A few specimens were mounted upon branches projecting from an artificial grotto. The collection was of value only as a faunal exhibit and on account of the rare species it contained.

Costa Rica.—By far the best exhibit of birds made by any of the Central or South American countries was that shown by the Republic of Costa Rica in its own building. This collection, consisting of 267 mounted specimens, representing nearly the same number of species, represented very fairly the more characteristic birds of Costa Rica. The specimens were, as a rule, well mounted and carefully labeled; but some of the labels had been transposed, and the arrangement of the specimens was hardly satisfactory.

United States of Colombia.—The Colombian Government exhibited, in its own building, a collection of some of the characteristic birds of that country. These consisted of the so-called "Bogota" skins, such as are exported in large quantities from the capital of that name, but are gathered by native collectors from the surrounding country, often at a considerable distance from the city.

British Guiana.—The government of British Guiana exhibited,

through the Colonial Museum at Georgetown, a very good collection of the birds of that country, in the form of unlabeled cabinet skins. Owing to lack of room the greater part of this collection could not be placed on public view, but was stored in chests beneath the show-cases. The skins were of excellent preparation, and represented nearly all the more characteristic and some of the rarer birds of that country. Other demands upon his time prevented the commissioner (Mr. J. J. Quelch, curator of the Colonial Museum), who had charge of the exhibit, from labeling this collection.

Trinidad.—The colonial government exhibited a mounted group of bright-colored birds, among which were some apparently from the adjacent mainland, since they are not recognized as species occurring in Trinidad.

Cuba.—Cuba exhibited one small collection, consisting of the more characteristic birds of that island.

Few of the United States made exhibits of birds, the only ones making a noteworthy attempt in this line being the States of North Carolina, Pennsylvania, Ohio, Illinois, and Minnesota. The first and last mentioned States exhibited only game birds. The effort of Pennsylvania was on a rather extensive scale, but could scarcely be considered successful. The intention was to show a number of the more characteristic native birds and other animals, with their natural surroundings, an idealized mountain slope, with its rocks, ravines, brooks, and shrubbery, forming the foundation and background. Different species were brought into wholly unnatural juxtaposition, and the result, as might be expected, was disappointing, while the bad taxidermy—some of the specimens being actually suspended head downward from the branches to which they were wired—added to the unfavorable impression received by the critical spectator.

Ohio's exhibit was of a less pretentious character, but unfortunately also not free from defects, the most serious of which were the frequent and conspicuous errors of naming,* caused apparently by the transposition of labels at the hands of some assistant having a very imperfect knowledge of the species. The collection comprised perhaps the greater part of the species known to occur within the State, mounted (not very well as a rule) on wooden pedestals.

The various minor governmental and private exhibits at the Exposition having thus been reviewed, it remains to consider those of the United States Government and that of the State of Illinois.

EXHIBIT OF THE UNITED STATES NATIONAL MUSEUM.

Naturally the exhibit of birds made by the United States National Museum was by far the largest and in some respects the most important of the ornithological exhibits shown at the Expositon. Leaving

*There were 19 glaring errors of this kind; some specimens were not labeled at all.

to the Division of Economic Ornithology and Mammalogy of the Department of Agriculture the exclusive field of economic relations, the National Museum had choice of all other subjects. Had ample time been available, and the requisite skilled labor obtainable,[a] more satisfactory results could have been obtained; but as both were wanting a considerable curtailment of the original plan of the exhibit became necessary, while the limited space assigned to the exhibit in the Government building required considerable further reduction.

The leading idea of the exhibit was that it should be made attractive as possible without sacrificing its scientific value; in other words, that it should educate as well as entertain, and convey to the observer in a popular manner information that is at the same time scientifically accurate.

The total number of specimens exhibited was 1017, of which 888 were mounted, singly, on museum pedestals, 56 in pairs or triplets on museum pedestals, and 73 in artistic groups with naturalistic accessories. Altogether they represented about 850 species, much the larger part being American, the chief exceptions being the birds of paradise (25 species) and foreign game birds (74 species).

As finally determined by the limitations of time, facilities, and space, the plan of the exhibit was as follows:

A. Artistic Groups of mounted birds, with naturalistic accessories, showing species of particular interest from some remarkable peculiarity of habits, or as illustrating some scientific cohistorical fact.
  I. Species of remarkable habits:
    1. Satin bower birds and their playhouse.
    2. California woodpeckers and their storehouse.
    3. Butcher birds and their larder.
    4. Crocodile birds and their host.
    5. Lyre birds and their dancing mound.
    6. Prairie chickens courting.
    7. Flamingoes and their nests.
    8. Swallow-tailed kite feeding.
    9. Jacanas walking on floating lily-pads.
    10. Carolina paroquets roosting.
  II. To illustrate protective coloration.
    11. Ptarmigans in winter.
    12. Ptarmigans in summer.
  III. Nearly extinct North American birds.
    13. Carolina paroquets.
    14. Ivory-billed woodpeckers.
    15. Passenger pigeons.
B. Grouped mounted birds, on walnut pedestals, to illustrate and explain the confusion and misapplication of popular names. (See descriptive list on page—.)

[a] The most serious obstacle encountered was the impossibility of obtaining a sufficient number of skilled taxidermists and artists to model the accessories. The open field for expert artists in these specialties has been, on account of the importance of the matter, made the subject of the concluding paragraphs of this report.

C. Single mounted specimens on walnut pedestals:

a. Synoptical series to illustrate the different American families of birds.
b. Game birds.
c. Birds of paradise.
d. Humming birds.
e. Wild turkey trap of colonial times.

The character of these several component parts of the exhibit may best be described by reproducing the information contained on the label which accompanied each, which is as follows:

A. Artistic groups.

I. *Species of remarkable habits.*

Playhouse of satin bower birds, *Ptilonorhynchus violaceus* (Vieill.): The bower birds are a peculiar group of birds found only in Australia and New Guinea, and are remarkable for the extraordinary structures which they build for recreation and to please their æsthetic taste. These structures vary in character according to the species, some of them being far more wonderful than the one here represented. The group here shown represents the satin bird or satin bower bird of Australia, and explains the nature of this curious habit better than any description. The decorations of these bowers, while usually consisting of brightly colored feathers and shells, include all sorts of conspicuous objects, as bleached bones, metal buttons, bits of gaily colored yarn or rags, etc.; and it is said that when the natives miss anything of the sort, they always search the "runs" of the bower birds for them. (See label of subfamily Ptilonorhynchinæ, family Paradisæidæ.)

Storehouse of California woodpeckers, *Melanerpes formicivorus bairdi* Ridgw.: The provident habits of the California woodpecker have often been mentioned in works on natural history. Small holes, just large enough to hold an acorn driven in lengthwise, are bored into the dead trunk or branch of a tree, and afterwards "plugged" with acorns, driven in so tightly as to be extracted with difficulty. Sometimes almost an entire dead tree is thus utilized, presenting "the appearance of being closely studded with brass nails, the heads only being visible." It has been stated that only those acorns are selected which contain the egg of a grub, and that the birds wait until the latter are well developed before they open the acorns; but this story has not been verified.

Butcher birds and their larder: The American butcher bird, or loggerhead shrike (*Lanius ludovicianus*), has the habit, in common with other species of shrikes, of impaling small animals and insects on thorns. The reason why it does so is not known with certainty. Possibly it is done only when its appetite is satisfied by eating other victims, or perhaps to assist in eating, its feet being weak and not adapted for holding objects of this kind, like those of hawks and owls. This group was prepared by Mr. Charles F. Adams, of Champaign, Ill., who procured the specimens at that place.

Crocodile birds, *Pluvianus ægyptius* (Linn.): Herodotus, the Greek historian (B. C. 484–420), thus describes this interesting bird: "As the crocodile lives chiefly on the river it has the inside of its mouth constantly covered with leeches; hence it happens that, while all other birds and beasts avoid it, with the *Trochilos* it lives at peace, since it owes much to that bird, for the crocodile when he leaves the water and comes out upon the land is in the habit of lying with his mouth wide open and facing the western breeze; and such times the *Trochilos* goes into its mouth and devours the leeches. This benefits the crocodile, who is pleased, and takes care not to hurt the *Trochilos*." More recent travelers confirm all of the above account, except the statement that the bird enters the crocodile's mouth; it seems, in fact, that the

Trochilos is careful not to do so, but with a watchful eye on the monster cautiously and deftly snatches the leeches from its jaws.

Lyre bird, *Menura superba*, Davies: The lyre bird is peculiar to Australia, where it inhabits the dense undergrowth of the forests. It is excessively shy, and far more often heard than seen, its voice being loud, varied, and often musical. "Among its many curious habits is that of forming small round hillocks, which are constantly visited during the day, and upon which the male is continually trampling, at the same time erecting and spreading out his tail in the most graceful manner, and uttering his various cries, sometimes pouring forth his natural notes, at others mocking those of other birds, and even the howling of the Dingo."

Courtship of prairie chickens, *Tympanuchus americanus* (Reich.): In the spring, when the grass upon the prairies grows green, the loud "booming" note of the male prairie chicken may be heard during the early morning hours from a great distance. This resounding note is a love call to the females, who come from far and near, and a challenge to other males who may be within hearing. When all have assembled the "performance" begins. The males strive to outvie each other in their display of brilliantly colored, inflated air sacs, erected neck tufts, and spread tails, as they bow and scrape, and parade before the admiring audience of the weaker sex. As sometimes happens with entertainments of the human species, these "dances" usually end in a "free fight" among the males, and the gathering ends in disorder.

American flamingoes and their nests, *Phœnicopterus ruber* Linn.: It has long been known that the flamingo builds a tall, chimney-like nest, composed of mud scraped up from the flats laid bare at ebb tide and deposited in layers one upon another. It was formerly supposed that the object in building the nest so high was to enable the setting female to "straddle" it, and thus easily dispose of her long legs. In fact, so firmly was this believed that until within a few years past the birds were represented in this position, both pictorially and by the taxidermist's art. The real purpose, however, of these tall nests is to raise the eggs above the highest limits of flood tide, for they are built upon mud flats which are daily covered by the water. The specimens here shown are from the Bahama Islands, where the nests are made of the decomposed white coral which chiefly constitutes the localities where the flamingoes breed; and the position of the bird upon her nest is carefully copied from a photograph taken from life.

Swallow-tailed kite feeding, *Elanoides forficatus* (Linn.): Of all the so-called birds of prey the swallow-tailed kite is the most graceful. Living mostly in the air, it floats, with bouyant flight, over the landscape, scanning the ground or trees beneath it for the small reptiles or large insects which constitute its food. When an object to its taste has been seen it swoops upon it, grasps it in its talons, and mounts again into the air and feeds upon it at leisure—always on the wing. Sometimes the object which it has seized slips from its grasp and falls whirling toward the ground; but with a rapid sweep of its blade-like wings and a twist of its cleft tail it descends with the swiftness of an arrow and speedily recovers it. This elegant kite inhabits the warmer parts of America, and is particularly numerous in the more open districts of the lower Mississippi Valley and Texas, where it is known as the snake hawk, or forked-tailed hawk, in allusion to its fondness for snakes and the peculiar form of its tail.

Mexican jacanas, *Jacana spinosa* (Linn.): The Jacanas are remarkable for their habit of walking easily upon the floating leaves of aquatic plants, for which their extremely long, slender toes and needle-like claws are admirably adapted. The species shown in this group inhabits Mexico and Central America, as well as the Greater Antilles and the extreme southeastern part of Texas, though it is rare in the last-named locality. The specimens are an adult male and female and a young bird collected on Lake Patzcuaro, in Michoacan, Mexico, by Mr. P. L. Jouy, of Washington.

Carolina paroquets, *Conurus carolinensis* (Linn.), roosting: The manner in which the Carolina paroquet sleeps is very curious. Instead of perching on a branch, as

most birds do, this species clings to the vertical inside of a hollow tree, where it holds on by both feet and bill, its tail being pressed against the wood as a prop. It may, in fact, almost be said to hang by its bill, for the tip of the hooked beak being inserted in a cleft of the wood, this point of contact no doubt supports a considerable part of the bird's weight. Frequently dozens, if not hundreds, of these birds occupy such a cavity as that here shown, a large cypress or sycamore being usually chosen, though the kind of tree is not so much a matter of importance as the character of the hollow—an essential point being that the cavity is open at the top and slants but little from a vertical direction.

Ptarmigans, *Lagopus lagopus* (Linn.), in winter plumage: Protective coloring is well shown in the ptarmigan, which becomes almost wholly white in winter, so as to be with difficulty distinguishable from the surrounding snow, and mottled brown in summer, like the dull-colored mosses, lichens, and rocks among which it lives, as shown in the accompanying group.

Ptarmigans, *Lagopus lagopus* (Linn.), in summer plumage: Protective coloring is well shown in the ptarmigan, which in summer is mottled brown, like the dull-colored rocks, mosses, and lichens which surround it, but in winter white, like the snowy mantle which at that season continuously covers the country where it resides, as shown in the accompanying group.

Carolina paroquets, *Conurus carolinensis* (Linn.), feeding: In Audubon's time this beautiful bird was common throughout the United States south of the parallel of 40°, and in places extended beyond that limit. It was particularly numerous in the Ohio Valley, where it remained during the severest winters, Prince Maximilian having observed in 1837, in southern Indiana, flocks flying about and apparently suffering no discomfort when the thermometer registered 26° below zero. At the present time the species is nearly extinct and no doubt will become entirely so within a few years. Several causes have brought about the great diminution in their numbers, one of the most prominent being their strong attachment to one another, a characteristic soon learned and taken advantage of by the settlers, as a result of which entire flocks were exterminated. It was only necessary to wound a specimen and capture it, when all those within hearing of its cries would fly about, screaming in sympathy, and allow themselves to be shot, one by one, until all were killed. Their habit of roosting together in large numbers inside of hollow trees also proved fatal to them, for the trees in which they roosted were often felled at night and the birds all killed. There were two incentives to their wholesale slaughter—they were exceedingly destructive to green corn and young fruits, the latter being cut to pieces chiefly for the seeds; and they were also excellent eating. The accompanying map shows, approximately, the extreme limits of the former range of the species and exceedingly restricted area to which it had been reduced in 1891, when data were compiled by Mr. E. M. Hasbrouck and published in The Auk for October, 1891, pages 369–371. In this group the paroquets are seen feeding on a favorite food, the cocklebur. Another group in this exhibit shows several birds of this species roosting inside a a hollow tree.

Ivory-billed woodpecker, *Campephilus principalis* (Linn.): Like the Carolina paroquet the ivory-billed woodpecker had formerly an extensive range, but has at present a very restricted one. In Audubon's time it extended northward along the Atlantic coast nearly, if not quite, to the Dismal Swamp, in southeastern Virginia, in the interior up the Ohio River to near Cincinnati, and along the Missouri River entirely across the State of the same name. In 1891, when data respecting its more recent range were compiled by Mr. E. M. Hasbrouck (published in The Auk for April, 1891, pp. 174–186), the extreme limits of its habitat were the southern portion of North Carolina (latitude 35°) near the coast, to a little above Vicksburg along the Mississippi, and westward along the Gulf coast to the Brazos River in Texas. The great reduction in the area inhabited by this large and powerful woodpecker has been brought about by increased settlement of the country and destruction of the

forests. It seems unable to withstand contact with civilized man, but as he encroaches on its domain retires to more secluded localities of constantly diminishing extent; and the time is doubtless not far distant when, from want of an abiding place, it will be numbered among the extinct birds of this country.

Passenger, *Ectopistes migratorius* (Linn.) pigeons feeding: There are doubtless thousands of the inhabitants of the United States who remember well the immense flights of "wild pigeons" which, a comparatively few years ago, passed back and forth between their feeding and roosting places, or during their migrations. The number of individuals which composed some of the flights seen in Audubon's and Wilson's time was estimated at some thousands of millions; and areas of forest more than 40 miles long and 3 miles wide were so completely occupied by their nests that many trees were broken down by the weight of the birds and their nests. The birds were killed in great numbers, those not wanted for immediate use being salted down in barrels and the hogs of the settlers turned loose in the woods to feed on the remainder. These great roosts and flights no longer exist, while in a very large part of the country where the birds were formerly abundant few, if any, have been seen for several years, and there is certainly not more than one bird of this species now where there were thousands only ten or fifteen years ago. The principal food of the passenger pigeon consists of beechnuts and acorns, particularly those of the water oak or pin oak (*Quercus palustris*), the species shown in the group here presented.

B. Mounted birds on walnut pedestals to illustrate and explain the confusion of popular names.

[Copy of case label.]

The confusion of popular names of many of our native birds, certain game birds in particular, has given much trouble to sportsmen and others not specially conversant with ornithological nomenclature. The subject is a complicated one, but it is hoped that the series of specimens herewith exhibited may, in connection with the labels, to a degree explain the matter.

When the English colonists settled in the United States, it was rarely they were able to give original names to the birds and other animals found in the new country, the few instances in which they were able to do so being in the case of species affording entirely new characteristics of voice, color, or habits, as, for example, the whip-poor-will, the bobolink, the bluebird, and the humming bird. In other cases they were content to apply names of more or less similar species they had been familiar with in England, though usually the resemblance was a distant or superficial one. It also sometimes happened that the New England and Virginia colonists gave different names to the same bird, and the same name to different birds, thus still further complicating the matter. This is well illustrated in the case of the names pheasant, partridge, and quail. Although neither of the three European birds so named occurs in any part of America, the three names were nevertheless transferred to two American birds—the ruffed grouse (*Bonasa umbellus*) and the bobwhite (*Colinus virginianus*). The former was called "partridge" in New England and "pheasant" in Virginia, while the latter was called "quail" in New England and "partridge" in Virginia. It thus occurs that the so-called partridge of New England is a totally different bird from that of Virginia, both being at the same time entirely different from the true partridge (*Perdix perdix*), which is not found in America at all. On the other hand, the so-called quail of New England is the same bird as the so-called partridge of Virginia, but is wholly different from the true quail (*Coturnix coturnix*), also not found in America; while the so-called partridge of New England and the so-called pheasant of Virginia are identical, though the bird is neither a partridge nor a pheasant, but belongs to the grouse family (*Tetraonidæ*), both the true partridge and the true pheasant belonging to the pheasant family (*Phasianidæ*).

The name ortolan is similarly misused in the United States, the true ortolan (*Emberiza hortulana*) being a European bird of the finch or sparrow family (*Fringillidæ*), while the two American birds, wrongly so called, belong to the hang nest and rail families (*Icteridæ* and *Rallidæ*), respectively.

Fifty-six specimens compose this series, representing 26 names, following being a complete list:

Name.	American species to which the name is wrongly applied.	European species to which the name properly belongs.
1. Buzzard	*Cathartes aura* (turkey vulture); family *Cathartidæ*.	*Buteo buteo;* family *Buteonidæ*.
2. Bee bird	*Tyrannus tyrannus* (king bird); family *Tyrannidæ*.	*Merops apiaster;* family *Meropidæ*.
3. Blackbird	*Quiscalus quiscula* (purple grackle); family *Icteridæ*.	*Merula merula;* family *Turdidæ*.
4. Carrion crow	*Catharista atrata* (black vulture); family *Cathartidæ*.	*Corvus corone;* family *Corvidæ*.
5. Coot	*Oidemia* (3 species); family *Anatidæ*	*Fulica atra;* family *Rallidæ*.
6. Chimney swallow	*Chætura pelagica* (chimney swift): family *Micropodidæ*.	*Chelidon rustica;* family *Hirundinidæ*.
7. Goldfinch	*Spinus tristis* (American goldfinch); family *Fringillidæ*.	*Carduelis carduelis;* family *Fringillidæ*.
8. Jackdaw	*Quiscalus major* (boat-tailed grackle); family *Icteridæ*.	*Corvus monedula;* family *Corvidæ*.
9. Jacksnipe	(1) *Gillinago delicata* (Wilson's snipe); family *Scolopacidæ*. (2) *Tringa maculata* (pectoral sandpiper); family *Scolopacidæ*.	*Gallinago gallinula;* family *Scolopacidæ*.
10. Kingfisher	*Ceryle alcyon* (belted kingfisher); family *Alcedinidæ*.	*Alcedo ispida;* family *Alcedinidæ*.
11. Martin	*Progne subis* (purple martin); family *Hirundinidæ*.	*Hirundo urbica;* family *Hirundinidæ*.
12. Oriole	*Icterus galbula* (Baltimore oriole); family *Icteridæ*.	*Oriolus galbula;* family *Oriolidæ*.
13. Ortolan	Potomac River, etc., *Porzana carolina* (sora); family *Rallidæ*. Louisiana, *Dolichonyx oryzivorus* (bobolink, reed bird); family *Icteridæ*.	*Emberiza hortulana;* family *Fringillidæ*.
14. Partridge	In New England, etc., *Bonasa umbellus* (ruffed grouse); family *Tetraonidæ*. In Virginia, etc., *Colinus virginianus* (bob white); family *Perdicidæ*.	*Perdix perdix;* family *Perdicidæ*.
15. Pheasant	In Virginia, etc., *Bonasa umbellus* (ruffed grouse); family *Tetraonidæ*.	*Phasianus colchicus;* family *Phasianidæ*.
16. Quail	In New England, etc., *Colinus virginianus* (bob white); family *Perdicidæ*. (The "partridge" of Virginia, etc.)	*Coturnix coturnix;* family *Perdicidæ*.
17. Redstart	*Setophaga ruticilla* (American redstart); family *Mniotiltidæ*.	*Ruticilla tithys;* family *Turdidæ*.
18. Redwing	*Agelaius phœniceus* (red-winged blackbird); family *Icteridæ*.	*Turdus iliacus;* family *Turdidæ*.
19. Robin	*Merula migratoria* (American robin); family *Turdidæ*	*Erithacus rubecula;* family *Turdidæ*.
20. Rook	Potomac River, etc., *Erismatura rubida* (ruddy duck); family *Anatidæ*.	*Corvus frugilegus;* family *Corvidæ*.
21. Screech owl	*Megascops asio* (mottled owl); family *Bubonidæ*.	*Syrnium aluco;* family *Bubonidæ*.
22. Sparrow hawk	*Falco sparverius* (American sparrow hawk); family *Falconidæ*.	*Accipeter nisus;* family *Buteonidæ*.
23. Tree sparrow	*Spizella monticola* (American tree sparrow); family *Fringillidæ*.	*Passer montanus;* family *Fringillidæ*.
24. Turtle dove	*Zenaidura carolinensis* (mourning dove); family *Columbidæ*.	*Turtur turtur;* family *Columbidæ*.
25. Yellow hammer	*Colaptes auratus* (flicker); family *Picidæ*	*Emberiza citrinella;* family *Fringillidæ*.
26. Woodcock	In longer settled districts, *Philohela minor* (American woodcock); family *Scolopacidæ*. In parts of Southern and Western States, *Ceophlœus pileatus* (pileated woodpecker); family *Picidæ*.	*Scolopax rusticola;* family *Scolopacidæ*.

C. SINGLE MOUNTED SPECIMENS ON PEDESTALS.

A. Synoptical series to illustrate American families of birds.

The total number of families shown is 104, these including not only those which are peculiar to the Western Hemisphere, but also those

which are common to America and the "Old World." In most cases, particularly among the smaller birds, each family was represented by several specimens in order to show variations of size, form, and plumage within each. The families were arranged as nearly as possible in the sequence of the most modern classification, the different orders being separated by conspicuous labels. Each family group was accompanied by a label upon which was printed, in easily read type, its more striking characteristics, expressed as much as possible in language easily understood by the nonscientific reader.

The number of genera and species in this series is shown in the following alphabetical list of the families, of which those peculiar to America are marked with an asterisk.

	Genera.	Species.
1. Alaudidæ (larks)	2	2
2. Alcedinidæ (kingfishers)	1	4
3. Alcidæ (auks)	4	5
4. Ampelidæ (wax-wings)	1	2
5. Anatidæ (swans, ducks, and geese)	20	21
*6. Anhimidæ (screamers)	1	1
7. Anhingidæ (anhingas)	1	1
8. Aphrizidæ (turnstones)	2	2
*9. Aramidæ (courlans)	1	1
10. Ardeidæ (herons)	6	6
11. Bubonidæ (owls)	12	12
*12. Bucconidæ (puff-birds)	4	5
13. Buteonidæ (hawks, eagles, kites, etc.)	8	8
14. Capitonidæ (barbets)	2	2
15. Caprimulgidæ (goatsuckers)	4	5
*16. Cariamidæ (cariamas)	1	1
*17 Cathartidæ (American vultures)	5	5
18. Certhiidæ (creepers)	1	1
*19. Chamæidæ (wren-tits)	1	1
20. Charadriidæ (plovers)	3	5
21. Chionidæ (sheathbills)	1	1
22. Ciconiidæ (storks)	1	1
23. Cinclidæ (dippers)	1	1
*24. Cochlearidæ (boat-bills)	1	1
*25. Cœrebidæ (honey creepers)	6	9
26. Columbidæ (pigeons or doves)	7	8
27. Colymbidæ (grebes)	2	4
*28. Conopophagidæ (ant-pipits)	1	1
29. Corvidæ (crows and jays)	13	15
*30. Cotingidæ (cotingas)	18	24
*31. Cracidæ (curassows)	5	5
32. Cuculidæ (cuckoos)	7	7
*33. Deudrocolaptidæ (wood-hewers)	5	5
34. Diomedeidæ (albatrosses)	1	2
*35. Dulidæ (palm chats)	1	1
*36. Eurypygidæ (sun bitterns)	1	1
37. Falconidæ (falcons)	5	8
*38. Formicariidæ (ant birds)	7	9
39. Fregatidæ (frigate birds)	1	1
40. Fringillidæ (finches)	29	29
*41. Furnariidæ (oven birds)	6	6
*42. Galbulidæ (jacamars)	3	3
43. Gruidæ (cranes)	1	1
44. Hæmatopodidæ (oyster-catchers)	1	1
45. Heliornithidæ (sun grebes)	1	1
46. Hirundinidæ (swallows)	5	5
47. Ibididæ (ibises)	2	2
*48. Icteridæ (hang-nests)	14	18
49. Jacanidæ (jacanas)	1	1
50. Laniidæ (shrikes)	1	1
51. Laridæ (gulls and terns)	4	5
*52. Meleagridæ (turkeys)	1	1
53. Micropodidæ (swifts)	3	3
*54. Mimidæ (mocking-thrushes)	11	11
*55. Mniotiltidæ (wood warblers)	15	19
*56. Momotidæ (motmots)	4	4
57. Motacillidæ (wagtails and pipits)	3	3
58. Œdicnemidæ (thick-knees)	1	1
*59. Opisthocomidæ (hoatzin)	1	1
*60. Oxyrhamphidæ (sharp-bills)	1	1
61. Pandionidæ (ospreys)	1	1
62. Paridæ (titmice)	4	4

	Genera.	Species.
63. Pelecanidæ (pelicans)	1	1
64. Pelecanoididæ (diving petrels)	1	1
65. Perdicidæ (partridges)	10	11
66. Phaëtontidæ (tropic birds)	1	1
67. Phalacrocoracidæ (cormorants)	1	1
68. Phalaropodidæ (phalaropes)	2	3
69. Phœnicopteridæ (flamingoes)	1	1
*70. Phytotomidæ (plant-cutters)	1	1
71. Picidæ (woodpeckers)	14	16
*72. Pipridæ (manakins)	8	13
73. Plataleidæ (spoonbills)	1	1
74. Procellariidæ (petrels)	3	3
*75. Psophiidæ (trumpeters)	1	1
76. Psittacidæ (parrots)	14	19
*77. Pteroptochidæ (tapacolas)	5	5
*78. Ptilogonadidæ (silky flycatchers)	3	4
79. Rallidæ (rails, gallinules and coots)	6	6
80. Recurvirostridæ (avocets and stilts)	2	2
*81. Rhamphastidæ (toucans)	5	10
*82. Rheidæ (rheas)	.....	(a)
83. Rynchopidæ (skimmers)	1	1
84. Scolopacidæ (snipes, sandpipers, etc.)	8	10
85. Sittidæ (nuthatches)	1	3
86. Spheniscidæ (penguins)	2	2
*87. Steatornithidæ (oil birds)	1	1
88. Stercorariidæ (skuas)	2	2
89. Strigidæ (barn owls)	1	1
90. Sturnidæ (starlings)	1	1
91. Sulidæ (gannets)	1	2
92. Sylvüdæ (warblers)	2	3
*93. Tanagridæ (tanagers)	22	30
94. Tetraonidæ (grouse)	7	7
*95. Thinocorüdæ (partridge-plovers)	2	2
*96. Tinamidæ (tinamous)	4	6
*97. Todidæ (todies)	1	1
*98. Trochilidæ (humming birds)	.....	(b)
99. Troglodytidæ (wrens)	5	6
100. Trogonidæ (trogons)	4	6
101. Turdidæ (thrushes)	7	7
*102. Tyrannidæ (tyrant flycatchers)	12	13
103. Urinatoridæ (loons)	1	2
*104. Vireonidæ (vireos)	3	5
Total	445	537

[a] Specimens of this family being much too large to put in the case, colored drawings of two species, representing different genera, were substituted.

[b] This family was shown by a special collection of 140 specimens, representing 90 species and 67 genera, in a separate case.

To reproduce here each one of the 104 family labels would, of course, be unnecessary, besides swelling to an undesirable extent the volume of this report, but several of them are reprinted to show the character of the information which they conveyed. It may be premised, by way of apology for any shortcomings which may be apparent in these labels, that it is far more difficult to express upon so limited a surface enough of the diagnostic characters of a family to clearly define it and at the same time a sufficient amount of such other matter as will render it readable by the general public, than when the necessity for condensation is not so pressing.

Family *Fregatidæ*, the man-o'-war birds: The man-o'-war birds, or frigate pelicans, are large, long-winged, fork-tailed, four-webbed sea-birds, with cormorant-like bill, excessively short legs, and small, imperfectly webbed feet. They are most nearly related to the cormorants, but are very different in habits. Their powers of flight are unsurpassed, and it has been said that the same individual man-o'-war bird may, on the same day, breakfast in Africa and dine in America—doubtless, however, a considerable exaggeration. Only two species are known, both of which are of intertropical distribution, one of them restricted chiefly to the waters of the southern hemisphere.

Family *Columbidæ*, the pigeons: The pigeons or doves, are a very circumscribed group of birds, characterized by many peculiarities of structure, both internal and external. They have the basal portion of the bill covered by a soft skin, in which are situated the slit-like nostrils, overhung by a fleshy or tumid valve, the tip of the bill being hard and somewhat arched; the hind toe is well developed and on a level with the anterior toes. Most other characters are extremely variable. They are both terrestrial and aboreal, and their food consists either of seeds of various kinds, or fruits, some kinds subsisting chiefly, if not entirely, on the latter. They lay only two eggs, which are always plain colored, usually white, but sometimes buff. The family is quite cosmopolitan, though wanting in very cold regions, and very numerous in species, of which America possesses more than 80, referable to 14 genera. (See series of species in game-bird collection.)

Family *Anatidæ*, the ducks, geese, and swans: The ducks, geese, and swans together constitute a well-marked group of water birds. They all have a straight, often flattened, bill, the edges of which are provided with "strainers" in the form of fine transverse lamellæ or tooth-like processes, comparatively short legs, and webbed feet, with a small elevated hind toe.

Next to the gallinaceous birds they constitute the most important group of birds, on account of their value for food, for their feathers, or their down, and the ease with which they are domesticated.

The family is entirely cosmopolitan in its distribution, and numerous in species, America possessing nearly 100, belonging to some 35 genera.

Family *Anhimidæ*, the screamers: The screamers, notwithstanding their massive legs and feet, cleft toes, and short-curved beak, have been clearly demonstrated to be more nearly related to the ducks and geese (family *Anatidæ*) than to any other group of living birds. They inhabit marshes and lagoons in open districts, where they both wade and swim, and they also perch upon trees. The double-edged, knife-like spur with which their wings are armed renders them formidable antagonists; and so bold and pugnacious are these birds that they are often tamed by the natives and employed as herders and protectors to the poultry, which they effectually defend against birds of prey and other enemies. The family is peculiar to eastern South America, where occur three species belonging to two genera.

Family *Paradisæidæ*, subfamily *Ptilonorhynchinæ*, the bower birds: The bower birds constitute a distinct group of the *Paradisæidæ*, characterized by absence of ornamental plumes, plainer colors (though some of the species are beautiful birds), and more terrestrial habits; but most of all, by their extraordinary habit of building bowers or playhouses, which are sometimes wonderful affairs, displaying a highly æsthetic taste on the part of the builders. One of these structures is reproduced in a group which forms part of this exhibit; but this is a very ordinary affair compared with the much more elaborate and artistic structures of certain other species. A plain brown bird of the genus *Amblyornis*, for example, found in New Guinea, constructs, around the slender stem of an upright shrub, a circular edifice of different mosses which forms the base and support of a conical hut, whose roof is impervious to the weather. The "rafters" of this roof are the slender branches of a parasitic orchid, which retain their leaves, still growing. Directly in front of the hut is a level space carefully covered with fine, soft mosses, kept scrupulously free from dirt, but strewn with brightly colored fruits, flowers, and fungi, so as to present the appearance of a miniature flower garden; and when these fade or become wilted they are removed and replaced by a freshly gathered supply. This reads like romance, but is a well-ascertained fact.

Family *Trochilidæ*, humming birds: The humming birds comprise a very extensive and varied group of small Picarian birds, characterized by the highly specialized bill and tongue and related parts, the purpose of which is adaptive. They obtain their food from flowers, either in the form of nectar or minute insects, in order to

obtain which the bill must be lengthened so that they can penetrate the deepest recesses of the flowers, and the tongue extensile to aid them in doing so, as well as to assist in extracting the nectar from the glands containing it and insects from their hiding places. In all respects except the construction of the head they resemble the swifts more closely than any other birds. From all birds, however, the humming birds differ in the structure of the wing, the secondaries being only 6 in number and excessively short, not reaching so far as the tips of the primary coverts. In some respects the humming birds constitute the most interesting of all bird groups. Many of its members are much the smallest of all birds, while a large proportion of them are adorned with plumage unparalleled among other birds in the richness and metallic luster of its iridescent colors. It is also one of the most varied and numerous of all families of birds, about 500 species being already known, among which are no less than 127 generic types. The family is exclusively American, chiefly tropical, and most numerously represented in the headwaters of the Amazon, in Ecuador, and Peru.

Family *Troglodytidæ*, wrens: The wrens are small song birds, with 10 primaries, slender bill without distinct bristles about the gape, the inner toe united by at least half of its basal joint to the middle toe, and the tarsi distinctly scutellate. They are birds of variable appearance and habits, though mostly agreeing in a dull brownish, more or less barred, coloration, and semiterrestrial habits. Many are fine songsters. The family is poorly represented in the eastern hemisphere, where only 15 species, referable to 5 genera, are known; these restricted to Europe and the temperate parts of Asia, chiefly the latter. In America, however, it is numerously developed, especially within the Tropics, nearly 150 species, belonging to 14 genera, being known to occur there.

Family *Picidæ*, the woodpeckers: The woodpeckers are a numerous but sharply circumscribed group of "yoke-footed" picarian birds, most nearly related, perhaps, to the barbets (family *Capitonidæ*). They differ from all other birds in the structure of the beak and tongue, together with related parts, which are highly specialized for adaptation to their peculiar mode of obtaining their food. The bill is a combined hammer and chisel, and serves admirably for the puncturing and excavation of trees, both for the purpose of reaching insects which are hidden in the wood and preparing a cavity for nesting purposes. The tongue is an extensile barbed lance or spear, with which they are able to explore the burrow of a grub, transfix it, and draw it within the mouth; and its fleshy portion is covered with a viscid secretion which entraps insects with which it comes in contact. Woodpeckers are found in most parts of the world, but are entirely wanting in Australia, New Zealand, and Polynesia. They are most numerous in America, where occur more than 200 species, referred to about 22 genera—or more than half the known species and a little less than half the genera of the entire world. Like nearly all picarian birds, the woodpeckers lay pure white eggs, which they deposit in holes in trees, usually excavated by themselves, often in the living wood. A few species, inhabiting treeless districts, make burrows in the ground.

Family *Procellariidæ*, the petrels: The petrels are oceanic birds of buoyant and protracted flight, with fully webbed anterior toes and rudimentary hind toes; tubular, "double-barreled" nostrils, on top of the culmen, and hooked beak. The species are very numerous, about 70, belonging to some 20 genera, being known and abound most in the southern hemisphere. They range in size from the diminutive storm petrels or Mother Carey's chickens, no larger than a sparrow, to the albatross-like giant Fulmar. They nest in burrows which they make in the soil of hillsides or in natural recesses among cliffs, and deposit a single white egg. The petrels eject from their nostrils a fetid oily substance, and it has been suggested, with good reason apparently, that one purpose of this is to quiet the surrounding waves as they rest upon the surface of the sea.

Family *Colymbidæ*, the grebes: The grebes are swimming birds with the legs exserted from the posterior extremity of the body, the toes lobed and half-webbed and terminated by broad, flat nails instead of claws of the usual form; tail rudimentary, consisting merely of an inconspicuous tuft of small, loose-webbed feathers instead of true tail feathers. Their nest is a floating mass of vegetable material, usually anchored to some aquatic plant, and their eggs (2 to 5 in number) plain whitish, though usually stained by contact with the decaying vegetable matter of the nest.

They are expert divers, feed chiefly on small fishes, and their flesh is unfit for food.

The skin of their under parts, however, is in great demand for trimming ladies' hats, muffs, etc., on account of its dense glossy covering of silky feathers.

Their range, as a family, is nearly cosmopolitan; about 20 species, referable to 5 or 6 genera, are known, 10 species and 4 genera occurring in America.

Family *Alcidæ*, the auks: The auks are three-toed swimming birds with feet situated far back, the anterior toes fully webbed, their claws normal, sometimes strongly hooked, the bill extremely variable in shape. They differ from the loons, their nearest allies, in the entire absence of a hind toe, and of a membrane overhanging the nostril. Peculiar to the seas and coasts of the more northern parts of the northern hemisphere, they represent there the penguins of the Antarctic seas—with one exception, however—they possess the power of flight, usually to a marked degree; but the great auk (*Plautus impennis*), extinct since 1844, was quite unable to fly. The family is represented by about 12 genera and 28 species, all of the former and all but 3 of the latter occurring in North America.

Family *Spheniscidæ*, the penguins: The penguins are oceanic birds, peculiar to the Antarctic seas, where they represent the auks (family *Alcidæ*) of the Arctic waters. They are peculiar in having their feathers uniformly distributed over their whole surfaces (except bill and feet), and in having the quill feathers rudimentary, or hardly distinguishable from the closely set, scale-like feathers which correspond to the wing coverts of other birds. Hence the penguins are incapable of flight, the only function of their wings being as propellers, their feet being used to guide rather than force them through the water. They are as much at home in the sea as are the seals among mammals, and resort to the land chiefly for the purpose of reproduction. They breed in large colonies on rocky coasts. About 8 genera and 18 species are known, more than half of them inhabiting the seas skirting the extreme southern portion of America.

In addition to these family labels, each individual specimen bore a species label, a sample of which is herewith given, on which was printed the English and scientific names (with authority for the latter) and the geographical range.

B. GAME BIRDS.

The collection of game birds comprised 179 specimens, representing 132 species, belonging to 79 genera, distributed among the several families, as follows:

	Genera.	Species.	Specimens.
Tetraonidæ (grouse), American forms[1]	6	23	47
Tetraonidæ (grouse), Old-World forms	4	5	7
Perdicidæ (partridges and quails), American forms[1]	7	10	22
Perdicidæ (partridges and quails), Old-World forms	10	13	13
Phasianidæ (pheasants), Old World exclusively	14	27	33
Meleagridæ (turkeys), American exclusively	1	4	6
Numididæ (guinea fowls), peculiar to Africa	2	3	3
Megapodidæ (mound fowl), peculiar to the Australian region	2	3	3
Cracidæ (curassows), peculiar to tropical America[1]	2	2	2
Gouridæ (crowned and pigeons), peculiar to New Guinea	1	2	2
Columbidæ (pigeons or doves), Old-World forms only[2]	16	21	21
Anatidæ (swans, ducks, and geese), American forms only[1]	14	18	20
Total	79	132	179

Game birds: The collection of game birds here exhibited includes the principal kinds, it being necessary, on account of inadequate space, to limit its extent. The exhibition of foreign species is attempted only with the gallinaceous birds and pigeons, the various waterfowl classed as game birds being restricted to North American species. Special attention has naturally been paid to the North American species of gallinaceous birds, of which every known species and race is represented.

C. BIRDS OF PARADISE.

Birds of paradise, family *Paradisæidæ:* The birds of paradise are famed for the magnificence of their plumage, and in the extraordinary development of ornamental plumes they certainly excel all other birds. Their early history was involved in much that is purely mythical. They were supposed to live entirely in the air, never touching the earth until they died; and having, therefore, no use for feet did not possess them. The last-mentioned myth resulted from the circumstance that the dried skins of these birds which came into possession of the early Dutch and Portuguese traders had been deprived of their legs by the natives, who, to explain their absence, told the traders that the birds did not possess such useless appendages. It was on this account that Linnæus named the great bird of paradise *Paradisæa apoda*—i. e., the footless bird of paradise—and so it is known to this day.

Through the observations of Mr. Alfred Russell Wallace and others, who have seen the living birds in their native forests, their general habits are now fairly well known; and the systematists who have studied their structure have shown them to be closely allied to several families of ordinary passerine birds; indeed, it has been found that the typical birds of paradise are so closely allied to the crows (family *Corvidæ* and Orioles (family *Oriolidæ*) that it is difficult to find characters to sharply define them as a distinct family.

Remarkable as the ornamental plumes of these birds appear in stuffed specimens, they are far more wonderful in the living birds, for they can be raised, spread, and moved about at the owner's will, and thus made to produce most startling effects. Observe, for example, the specimens of the six-shafted bird of paradise (*Parotia sefilata*). The Count d'Albertis, who was the first naturalist who saw living examples of this species, says, of one which he subsequently shot, that it began its display by moving the long feathers of the head and raising and lowering the small tuft of white feathers above its beak, which shone in the sun like polished silver; the burnished golden feathers on the throat were then raised and lowered, glittering the while like bits of bright metal; the long feathers of the sides were alternately spread and closed, making him appear now larger, then smaller, than his real size; "and jumping first on one side, then on the other, he placed himself proudly in an attitude of combat, as though he imagined himself fighting with an invisible foe."

The males of the species of *Paradisæa* are said to alight upon the summit of a tall dead tree, overlooking the forest, and there in the full sunlight spread their plumes and pose before an admiring audience of the plainer sex.

The birds of paradise are peculiar to Papua, or New Guinea, with its attendant islands, and neighboring parts of Australia, though none of the subfamily *Paradisæinæ* occur in the latter country.

D. HUMMING BIRDS.

Humming birds, family *Trochilidæ:* Of all the many groups into which the class of birds is divided, there is none other so varied in form, so brilliant in plumage, and so different from all others in their mode of feeding, while few, if any, are so numerous in species. Inhabitants exclusively of the tropical and temperate portions of America, they constitute the most charming element in the wonderfully varied bird life of the New World.

The general habits of humming birds are similar to those of other birds. They are both arboreal and aerial, but are unable to progress upon the ground or any flat surface by means of their legs and feet alone. They perch frequently upon trees or bushes, or even in rare instances cling to rocks, and their mode of nidification presents nothing that may be deemed peculiar or even specially characteristic. But in their flight and manner of procuring their food they differ strikingly from other birds, in these respects much more closely resembling certain insects than members of the "feathered tribe."

In feeding from flower to flower humming birds, like bees and butterflies, besides obtaining nourishment for themselves, perform in the economy of nature the same office as insects, by transferring pollen from one bloom to another, and thus assisting in the fertilization of plants.

Diminutiveness of size and brilliancy of coloring are the chief external characteristics of humming birds, and in these respects, they, as a rule, have no rivals. Unfortunately, stuffed specimens convey but a faint idea of their splendid coloring; the perfection of their changeable refulgence can be fully realized only in the living bird, whose every motion produces a flash-like change of hue—emerald green replacing ruby red, or either becoming velvet black—according to the angle at which the sun's rays touch the feathers; while stuffed specimens, being always in one position, can only show one set of colors at the expense of another. For example, some kinds have an intensely brilliant spot of emerald green on the forehead and a spot of metallic blue, purple, or crimson on the throat. Of course only one of these ornaments can be seen in the stuffed specimen at the same instant or from one position. Again, some species have a spot of one brilliant color on the throat and another of a totally different hue just beneath it; these can not be seen together, though slight changes in the position of the body will show first one, then the other.

(See also the label for the family *Trochilidæ*.

EXHIBIT OF DIVISION OF ECONOMIC ORNITHOLOGY AND MAMMALOGY, DEPARTMENT OF AGRICULTURE.

This fine exhibit was based upon the work done in the two branches of research conducted by the division, namely, the geographic distribution of birds and mammals and the food habits of the various species; both subjects of direct economic importance to agriculture, the former by determining, with an exactness to be otherwise reached only by protracted and costly experiment, the geographic areas suited by climate and local conditions to the cultivation of standard products, the latter as showing whether a given species is, from the character of its food, beneficial or injurious to the farmer. Each of these subjects, in its various details, was graphically illustrated by models, maps, and mounted specimens, the latter accompanied by appropriate accessories to show the natural environment, food, and other pertinent matters in the life history of the various species.

The several individual subjects together constituting this exhibit may be classified as follows:

A. GEOGRAPHIC ILLUSTRATIONS.

1. Idealized mountain slope to show successive faunas and floras of different elevations.
2. Topographic relief map of the area covered by the Death Valley Expedition.

3. Relief map of the United States showing faunal areas or life zones, accompanied by enlarged photographs of desert scenery with characteristic animals and plants.
4. Maps (about 50 in number) of the United States colored to show areas inhabited by particular species.

B. ECONOMIC RELATIONS.

a. Individual species with artistic accessories to show natural environment and food supply.
   1. Group of crows (*Corvus americanus*) feeding in a newly planted cornfield.
   2. Northern shrike or butcher bird (*Danius borealis*) perched on a thorny branch eating an English sparrow; impaled on neighboring thorns are remains of field mice and grasshoppers.
   3. English sparrow (*Passer domesticus*) destroying peach buds and blossoms.
   4. King birds or bee martins (*Tyrannus tyrannus*) and nest, the latter on an apple bough bearing leaves and green fruit. One bird has a honeybee in its bill, the other catching rose bugs.
   5. English sparrow (*Passer domesticus*) attacking a robin (*Merula migratoria*) on a lawn.
   6. Crow blackbirds (*Quiscalus quiscula*) searching among meadow grass for insects and larvæ.
   7. Yellow-billed cuckoo (*Coccyzus americanus*), eating caterpillars among fresh foliage and bloesoms of an apple tree.
   8. Cedar birds or cedar waxwings (*Ampelis cedrorum*), feeding on the elm-leaf beetle on a drooping branch of an elm.
   9. Bobolinks (*Dolichonyx oryzivorus*) on their nesting ground, representing a pair with their nest and eggs.
   10. Bobolinks transformed (by post nuptial molt) into "rice birds," gorging themselves with ripening rice.
   11. Red-tailed hawks (*Buteo borealis*) perched on a dead tree top, one of them with a meadow mouse under its foot.
   12. Red-shouldered Hawks (*Buteo lineatus*); two adults and an immature bird.
   13. Sparrow hawks (*Falco sparverius*), one of them eating a meadow mouse.
   14. Cooper's hawk (*Accipiter cooperi*) with a dying flicker or golden-winged woodpecker in its claws.
   15. Mottled owls (*Megascops asio*).
   16. Long-eared owl (*Asio wilsonianus*).

b. Special food exhibits:
   1. Characteristic food materials of various hawks and owls.
   2. Characteristic food materials of crows, blackbirds, bobolinks, cuckoos, shrikes, and cedar birds.

c. Samples of nesting boxes for the protection and encouragement of valuable native birds.

These separate features of the exhibit may be described as follows:

MODEL OF A MOUNTAIN SLOPE IN SOUTHERN CALIFORNIA, SHOWING THE DIFFERENT LIFE ZONES.

[Copy of label.]

This model is intended to bring before the eye at a glance characteristic representatives of the faunas of successive elevations from the Sonoran desert at the base to

the arctic-alpine summit, thus illustrating all the life zones of North America, from the table-land of Mexico to the Arctic Circle. The particular area represented is the East or Great Basin slope of the Sierra Nevada, opposite Owens Lake, with a strip of desert at the base. Two species are included from the west slope, and one from the deserts farther east.

The following zones and species are represented, beginning at the bottom:

1. *Lower Sonoran Zone.*—Covers the deserts east of the Sierra, including Panamint and Death valleys, and the Amargosa desert. The most conspicuous and widespread plant of this zone is the creosote bush (*Larrea tridentata*). The most characteristic mammals are the 4-toed kangaroo rats (*Dipodomys*), the large pocket mice (*Chætodipus*), the scorpion mice (*Onychomys*), the cliff mice (*Sitomys eremicus*), the white-tailed or antelope ground squirrel (*Spermophilus cucurus*), the desert wood rat (*Neotoma mexicana*), and the Sonoran desert fox (*Vulpes macrotis*). The most characteristic birds are Le Conte's thrasher (*Harporhynchus lecontei*), cactus wren (*Heleodytes brunneicapillus*), the black-throated desert sparrow (*Amphispiza bilineata*), the chaparral cock (*Geococcyx californianus*), and Gambel's quail (*Callipepla gambeli*).

2. *Upper Sonoran Zone.*—Covers the greater part of Owens Valley and the lower slopes of the Sierra. The most conspicuous and widespread plant of this zone is the sagebrush (*Artemesia tridentata*). The most characteristic mammals are the 5-toed kangaroo rats (*Rerodopus*), the small pocket mice (*Rerognathus*), and the sagebrush spermophile (*Spermophilus mollis*). The gray fox (*Urocyon*) and the badger (*Taxidea*) occur, but inhabit some of the other zones also. The most characteristic birds are Brewer's sparrow (*Spizella breweri*), sage thrasher (*Oroscoptes montanus*), the lark finch (*Chondestes grammacus strigatus*), and Woodhouse's jay (*Aphelocoma woodhousei*). The California Valley quail (*Callipepa californica vallicola*) is abundant in parts of this zone.

3. *Transition Zone.*—A narrow zone intervening between the Upper Sonoran and the Boreal. Like the Upper Sonoran, it is covered by sagebrush (*Artemisia tridentata*), and parts of it are sparsely wooded by junipers and nut pine. The most characteristic mammal in this region is the sage plains chipmunk (*Tamias minimus pictus*), which is replaced on the west slope by *Tamias merriami*. The most characteristic birds are the Nevada sage sparrow (*Amphispiza belli nevadensis*), the green-tailed towhee (*Pipilo chlorurus*), and the plumed quail (*Oreortyx pictus plumiferous*).

4. *Boreal Zone.*—A broad zone comprising the timber-covered upper slopes, on which the dominant trees are spruces and firs. In the High Sierra the most characteristic mammals are the golden-shouldered ground squirrel (*Spermophilus chrysodeirus*), Belding's ground squirrel (*Spermophilus beldingi*), California pine squirrel (*Sciurus californicus*), the Sierra chipmunk (*Tamias speciosus*), and bushy-tailed wood rat (*Neotoma cinerea*), mice of the genus *Arvicola*, and shrews of the genus *Sorex*. The characteristic birds are Clark's crow or nutcracker (*Picicorous columbianus*), blue-fronted jay (*Cyanocitta stelleri frontalis*), mountain bluebird (*Sialia arctica*), and the dipper or water ouzel (*Cinclus mexicanus*).

5. *Arctic-Alpine Zone.*—Comprises the higher summits of the mountains above the upper limit of tree growth. This zone is characterized by a number of small flowering plants, and is inhabited by the mountain sheep or bighorn (*Ovis canadensis*), the pika (*Lagomys*), and the mountain marmot (*Arctomys flaviventer*). The most characteristic bird of the Arctic-Alpine zone in the High Sierra is the gray-crowned rosy finch (*Leucosticte tephrocotis*).

Then follows a "Key to species on the model," which, being a mere list of names with numbers to correspond with those attached to the specimens, it is unnecessary to reproduce here. The species number 29 of mammals and 19 of birds.

TOPOGRAPHIC RELIEF MAP OF THE AREA COVERED BY THE DEATH VALLEY EXPEDITION.[a]

The area covered by this relief map, comprising about 100,000 square miles in California, Nevada, Utah, and Arizona, contains the highest elevations and deepest depressions in the United States, and is of very great interest both to the physiographer and biologist. The life zones, as on the adjoining relief map of the United States, were shown in different colors.

RELIEF MAP OF THE UNITED STATES, SHOWING FAUNAL AREAS OR LIFE ZONES, ETC.

The scale of the model is 1 inch = 40 miles. It shows the correct curvature at sea level, and is a section of a globe 16½ feet in diameter. Elevations and depressions above and below sea level exaggerated five times. Original model made for the United States Geological Survey by Edwin E. Howell.

The scheme of colors used is as follows: Boreal life zone equals green; Upper Austroriparian life zone equals yellow; Lower Austroriparian life zone equals dark yellow; Tropical life zone equals pink.

MAPS OF THE UNITED STATES COLORED TO SHOW AREAS INHABITED BY PARTICULAR SPECIES.

These maps (on a reduced scale) illustrated the geographic distribution of about 50 species of birds and mammals from data gathered by the division. The species were nearly all of western range.

ARTISTIC GROUPS WITH NATURAL ACCESSORIES.

Each group label is headed by a reduced outline map of the United States, with the area inhabited by the species to which it pertains colored. A reproduction of this heading, with the map uncolored, is given herewith, it being omitted from the labels which follow:

UNITED STATES DEPARTMENT OF AGRICULTURE, DIVISION OF ORNITHOLOGY AND MAMMALOGY.

Common crow, *Corvus americanus:* A group of crows seeking food in a cornfield. Some keep watch while the others pull the young sprouts, nip off the swollen kernels at the roots, and drop the blades on the ground. Incidentally the crow eats cutworms, wireworms, and white grubs in the cornfield, but his visits there are due principally to fondness for the sprouting corn. If the seed corn be lightly coated with a solution of tar before planting, the crows sample it and let the rest alone. An exhibit of crow food is shown in another case.

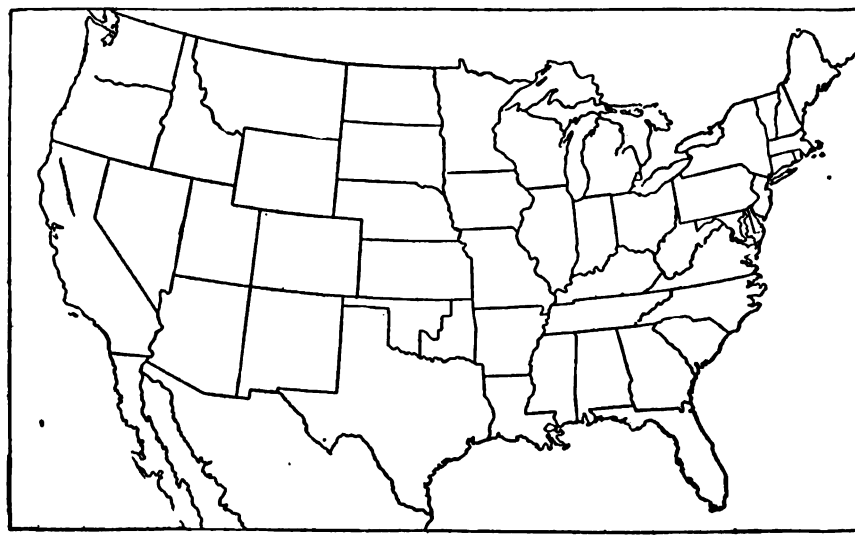
Butcher bird, *Lanius borealis:* The butcher bird, or northern shrike, nests mainly or entirely north of the United States, coming south only in cold weather. It possesses in a marked degree the habit, more or less common to all shrikes, of killing more food than is needed and suspending the surplus on thorns or sharp twigs near its favorite perch. The points of a barbed-wire fence frequently are utilized for this

[a] A biological survey conducted by the United States Department of Agriculture, Dr. C. Hart Merriam (Chief of Division of Economic Ornithology and Mammalogy), in charge. The map was compiled under the direction of A. H. Thompson, geographer, United States Geological Survey.

purpose. The butcher bird eats field mice, small birds, and insects, and has proved very useful in some city parks in winter by lessening the number of English sparrows. The origin and purpose of the habit of impaling its food never have been satisfactorily explained.

English sparrow, *Passer domesticus:* English sparrows, the world over, habitually destroy the buds and blossoms of fruit and shade trees. Sometimes the harm done is trifling, but in many cases the loss is serious. Generally the sparrows eat the centers of most of the buds, but in some cases they have been seen to mutilate the blossoms wantonly, eating no part of them. Peach trees are always attacked, but many others suffer almost as much, particularly the pear, cherry, plum, quince, apple, maple, beech, and elm.

Kingbird or bee martin, *Tyrannus tyrannus:* The nest, as usual, is placed on one of the upper branches of a neglected apple tree, the small green apples surrounding the nest. One of the birds holds a honeybee in its bill. Kingbirds are abundant and well known for their daring attacks on hawks and crows, as well as for their mischievous habit of catching hive bees. The latter habit does not seem to be universal,



The shading on map shows area of distribution.

but is confined to a few individuals. When the habit becomes fixed, however, the bird becomes a serious nuisance to bee keepers. The ordinary food includes many harmful insects, among them the well-known rose bug *Macrodactylus subspinosus.* These and other insects commonly eaten may be seen in a neighboring table case.

English sparrow, *Passer domesticus;* American robin, *Merula migratoria:* This group illustrates an incident of everyday occurrence during the nesting season of the robin. Two or more sparrows watch a female robin which is searching for earthworms or insects on the lawn. They keep at some distance and pretend to look for food themselves until the robin locates a worm and attempts to unearth it. Then the sparrows approach quickly and take positions on either side and usually a little behind her. When at last, with considerable effort, the robin drags the worm out of the ground, one of the robbers makes a dash at it, and if the robin eludes him by throwing her head in the opposite direction, another stands ready to snatch it. In places where sparrows are abundant this habit makes it almost impossible for robins to take food enough to their young to keep them from starving.

Crow blackbird, purple grackle, *Quiscalus quiscula:* Adult male and female, and full-fledged young, hunting for June bugs and their larvæ (white grubs) in damp grass land. The June bugs (*Allorhina*) and their allies, the May bugs (*Lachnosterna*), are eagerly sought for by blackbirds, and as the insects are serious pests to the agriculturist, the birds do good service by eating them. During spring and early summer the food of the crow blackbird is mainly of an animal nature, and insects form the larger part of it. At other seasons the diet is more largely vegetal, and the destruction of corn and other grain sometimes causes serious loss to the farmer. For exhibit of customary food see table case.

Yellow-billed cuckoo, *Coccyzus americanus:* Cuckoos feeding on caterpillars among apple blossoms. The caterpillar shown is the larva of the white-marked tussock moth (*Orgyia leucostigma*), one of the species most destructive to shade and fruit trees. Cuckoos eat insects of almost all kinds, but are particularly valuable because of their fondness for hairy caterpillars, which other birds can not or will not eat. The cuckoos of the United States, unlike those of Europe, usually build nests for themselves and rear their own young. They should be protected and fostered by every possible means. An exhibit of the customary food of cuckoos will be found in an adjoining table case.

Cedar bird, cedar waxwing, *Ampelis cedrorum:* Five birds on a bough of the common elm which is infested with elm-leaf beetles (*Galeruca xanthomelæna*). The bird is well known to fruit growers under the name of cherry bird from its fondness for that fruit. It also eats various other fruits, such as raspberries, blackberries, and mulberries, and, moving usually in flocks, it often does considerable damage. In spite of this it is a valuable friend to the farmer, since it eats immense numbers of harmful insects, among them the imported elm-leaf beetle, which in some cities has stripped the elms completely year after year. It also eats other beetles belonging to the same family (*Chrysomelidæ*), though all seem to be distasteful to most other birds. See food exhibit in table case.

Bobolink, *Dolichonyx oryzivorus*, male, female, and nest: Bobolinks during the nesting season are among the most musical and delightful of birds. The male in his black and white dress is a marvelous singer, and old and young feed largely on insects, rarely doing any harm whatever. Soon after the young are able to care for themselves the parents undergo a complete moult, and the male appears in nearly the same garb as his mate and young. In this plumage they migrate southward, and under the name of ricebirds do incalculable damage in the rice fields. See food exhibit in table case.

Ricebirds, *Dolichonyx oryzivorus:* During the nesting season at the North, the bob olink or ricebird is seen only in pairs or small family groups. In autumn, however, the birds unite in immense flocks in the rice fields of the Carolinas, Georgia, and the Gulf States, and cause untold loss to the planters. At this season male and female, old and young, are nearly alike in color and voice, and their buffy plumage harmonizes with the tints of the ripening grain, doubtless protecting them to a large extent from their natural enemies. Other birds, particularly the red-winged blackbirds (one of which appears in this group), unite with the ricebirds to pillage the rice fields, but the loss caused by blackbirds is comparatively small. See food exhibit in table case.

Red-tailed hawk, *Buteo borealis:* Two adults, male and female, and an immature bird, perched in the top of a dead tree. One of the adult birds holds a meadow mouse (*Arvicola riparius*) under its foot. This is one of the so-called hen hawks, but in reality it seldom attacks poultry, and is of great benefit to the farmer, since it feeds very largely on small rodents, particularly meadow mice, chipmunks, squirrels, and rabbits. See food exhibit in adjoining table case.

Red-shouldered hawk, *Buteo lineatus:* Adult male and female and immature male, perched in the top of a bare tree. This hawk is more often beneficial than harmful

to the agriculturist, though commonly called a "hen hawk" and confounded with other species. Its food is extremely varied, including mammals, birds, snakes, frogs, fish, insects, spiders, centipeds, crawfish, earthworms, and snails. A large part of the food, however, consists of injurious mice and squirrels. See table case for samples of the food eaten.

Sparrow hawk, *Falco sparverius:* Two males and a female, all adult and in winter plumage. The female holds under her foot a freshly killed meadow mouse (*Arvicola riparius*). This little falcon, so abundant in most parts of the United States, is of marked value to the agriculturist, since it prefers field mice and large insects to all other food, though occasionally it does catch a small bird, and, exceptionally, has been known to attack birds heavier than itself. It should not be confounded with the sparrow hawk of Europe (*Accipiter nisus*), the latter being a true bird hawk belonging to the same genus as the American sharp-shinned and Cooper's hawks. See exhibit of food of hawks in neighboring table case.

Cooper's hawk, *Accipiter cooperi:* A female in the act of killing a flicker or golden-winged woodpecker (*Colaptes auratus*). This is one of the few harmful hawks of the United States, and in most districts perhaps the most common. Farmers know it generally under the name of chicken hawk or little chicken hawk, and doubtless it kills most of the smaller chickens and domesticated doves whose disappearance commonly is attributed to the larger hawks. It is very destructive to feathered game and prefers wild birds to all other meat. However, it does some good by eating mice, squirrels, and the smaller rodents generally. See exhibit of food of hawks in neighboring table case.

Mottled or screech owl, *Magascops asio:* This is the most abundant and best known of the small owls, frequenting woods, orchards, and even city parks. In the latter situation it is a wholesome check on the English sparrow, and should be protected and encouraged unless native birds outnumber the sparrows. It eats great numbers of mice and injurious insects and is also fond of fish and crawfish. Under ordinary circumstances it is decidedly beneficial to the agriculturist. See food exhibit in adjoining table case.

Long-eared owl, *Asio wilsonianus:* A common owl in wooded regions, and, like most owls, decidedly beneficial to the farmer by consuming mice and insects. Occasionally it kills a small bird, but such variations are exceptional, the regular diet consisting of various species of mice and other small mammals.

SPECIAL FOOD EXHIBITS.

These exhibits were arranged under two categories, one consisting of an analysis of examinations made of the contents of a large number of stomachs of various hawks, owls, etc.; the other being specimens of "pellets or castings" of the same birds. A transcript of the labels, herewith given, more fully explains the nature of these exhibits:

Sparrow hawk, *Falco sparverius:* Of 320 stomachs examined, 1 contained a game bird (quail); 53, other birds; 89, mice; 12, other mammals; 12, reptiles or batrachians; 215, insects; 29, spiders, and 29 were empty.

Red-tailed hawk, *Buteo borealis:* Of 562 stomachs examined, 54 contained poultry or game birds; 51, other birds; 278, mice; 131, other mammals; 37, batrachians or reptiles; 47, insects; 8, crawfish; 1, centipeds; 13, offal, and 89 were empty.

Cooper's hawk, *Accipiter cooperi:* Of 133 stomachs examined, 34 contained poultry or game birds; 52, other birds; 11, mammals; 1, frog; 3, lizards; 2, insects, and 39 were empty.

Screech owl, *Megascops asio:* Of 225 stomachs examined, 1 contained poultry; 38,

other birds; 91, mice; 11, other mammals; 2, lizards; 4, batrachians; 1, fish; 100, insects; 5, spiders; 9, crawfish; 7, miscellaneous; 2, scorpions; 2, earthworms, and 43 were empty.

Pellets or castings: In the case of the birds of prey, as in some of the other orders, the indigestible portions of food, such as feathers, hair, bones, and the hard coverings of insects, are formed into balls by the movements of the stomach, after the nutritious portions have been absorbed. These masses, which are known as "pellets," are regurgitated from the stomach before a new supply of food is taken. The movements of the stomach so shape these "pellets" that every sharp piece of bone or hard material which might otherwise injure the mucous membrane is carefully enveloped by a felty covering of hair or feathers. In the case of some of the owls which have regular roosting places vast numbers of these pellets collect, and an examination of them will give a perfect index to the character of the food devoured.

Crow pellets or castings: Crows, as well as hawks and owls, disgorge the indigestible remnants of their food in the shape of balls or "pellets," the bones, shell, scales, seeds, and other hard materials being held together more or less perfectly by sand and gravel which are swallowed in large quantities as an aid to digestion.

Pellets or castings of the common crow, made up mainly of seeds of the poison ivy or poison oak (*Rhus toxicodendron*) and sand.

Components of a single pellet of the barn owl, showing the fur and bones of two meadow mice, 1 jumping mouse, and 1 short-tailed shrew. Skins of these mammals are shown also.

Bones of rats, mice, shrews, and other small mammals, all contained originally in 200 pellets or castings of the barn owl.

Pellets of the barn owl (*Strix pratincola*), showing smooth outer coating of felted hair.

NESTING BOXES FOR WILD BIRDS.

[Copy of label.]

These nesting boxes are designed to show forms and sizes well adapted to the various species of wild birds which often nest in the vicinity of dwellings, and whose presence it is desirable to encourage. In addition to the species here shown, several other birds are likely to use the same boxes; for example, the purple martin, white-bellied swallow, and Carolina wren, while many other species may be induced to nest near the house by providing such trees and shrubs as are preferred for nesting places or such as will furnish attractive fruit or seed. For birds which habitually nest in natural cavities, one of the most attractive boxes can be made by sawing off suitable lengths of hollow stubs or branches, closing one end with a plug or bit of board, and placing conveniently in shade or fruit trees out of the reach of cats. Gourds of suitable size form excellent nesting places for wrens, bluebirds, white-breasted swallows, and chickadees, and even empty fruit cans may be used to advantage.

EXHIBIT OF THE UNITED STATES FISH COMMISSION.

The United States Fish Commission exhibited a series of fish-eating birds, comprising 35 species, represented by 77 specimens. These, instead of being mounted, were simply well-made skins, appropriately labeled and neatly displayed behind glass. In cases of a marked difference of coloration between the upper and lower parts duplicate specimens were shown, one exposing the upper surface, the other the lower parts. Although well-mounted specimens would have been preferable from an artistic point of view, the necessity of condensing the

exhibit, as well as lack of sufficient time, prevented their use. But for all practicable purposes the method adopted answered the purpose for which the exhibit was intended quite as well as mounted specimens.

EXHIBIT OF THE ILLINOIS STATE LABORATORY OF NATURAL HISTORY.

No other State exhibit of birds was in any respect comparable with that made by Illinois, through the State laboratory of natural history, located at Champaign. This fine exhibit was planned by Prof. S. A. Forbes, director of that important institution, and approved by the State board of world's fair commissioners, and was prepared under the immediate supervision of Mr. C. F. Adams, of Champaign, who unfortunately died before the result of his work was installed for public view.

In order that only first-class material, prepared by modern methods of taxidermy, should be shown, Mr. Adams made a number of field trips, not only to secure specimens, but also to make careful studies of the chracteristic attitudes of the various species and their naturalistic environment, in order that these might be faithfully reproduced in the objects prepared for exhibition. Work was begun in the autumn of 1891, but by far the greater part of the material was gathered within the State during the year 1892 by parties sent out from the State laboratory of natural history.

Altogether, 775 mounted specimens of birds, representing nearly if not all the species and subspecies known to occur within the limits of the State (about 350 in number) were displayed, their classification and the number of specimens in each series being as follows:

Specimens mounted on museum pedestals.

	Specimens.
Summer residents throughout Illinois	207
Summer residents peculiar to northern Illinois	59
Summer residents peculiar to southern Illinois	38
Winter residents throughout Illinois	141
Winter residents of northern Illinois	44
Winter residents of southern Illinois	108
Migrants passing through Illinois	77
Stragglers in Illinois	24
Total number of specimens in faunal exhibit	698
Specimens mounted on plaques, common game birds of Illinois, mounted as dead game	53
Specimens mounted in artistic groups with naturalistic accessories:	
Wild turkeys	6
Prairie chickens	4
Crossbills (on larch bough)	8
Yellow-bellied sapsuckers (with nest and eggs)	4
Green herons (with nest and eggs)	2
Total number of specimens exhibited	775

In addition to this extensive collection of birds themselves, there was exhibited, in connection with them, 125 clutches of eggs, repre-

senting as many of the species which are known to nest within the limits of the State, the total number of eggs being 525.

As a State exhibit, this collection was in all respects an admirable one, and, taking into consideration the limited time allowed for its preparation, it is difficult to imagine how it could have been materially improved. In the conception of its plan Professor Forbes successfully solved the difficult problem of producing a popular presentation of a scientific subject, while the artistic execution of the work, in all its details, was quite abreast of the most advanced modern methods.

A careful study of the ornithological collections at the World's Columbian Exposition has clearly developed two conspicuous facts regarding stuffed-bird exhibits of the present time as compared with those of the period of the Centennial Exposition of 1876. One is the very great advance which has been made in the technique of the taxidermic art and the character of museum installation; the other is the very slight extent to which the improved methods have been utilized. The obvious explanation of this anomaly is to be found in the circumstance that few taxidermists are artists, and it requires the same degree of artistic skill to mount a bird well as it does to paint a picture well. Intimately associated with taxidermy as a factor in the production of educational exhibits of this kind is another art, as yet in the experimental stage, and in which, so far as it has been developed, still fewer persons have become proficient. I refer to the preparation of accessories for groups, which are intended to counterfeit the natural environment of the species as accurately as the skin stuffed by a master hand does the living bird.

The average taxidermist of the present day, even if he practices the modern methods of work, is capable only of productions which class him simply as an artisan; he is far from being an artist. He has "stereotyped" attitudes, more often copied from bad drawings than from living specimens; there is a lack of character to his work, no delicacy of finish, or it may be that the finishing is overdone, all resemblance to life being destroyed by elaborately smoothing down the plumage, which looks as if every trifling inequality of surface had been "ironed" out. If artistic groups are attempted, a more or less improbable, often impossible, aggregation of species are crowded together in a case, with gaudily painted and crudely formed artificial leaves and flowers, made specially for "the trade," added for embellishment. No special lesson is in view; nothing is thought of, in fact, but a massing of bright colors to "catch the eye." This constitutes the ordinary so-called "shop" taxidermy, too often employed in museums of the present day. Decorative taxidermy, so called, is not necessarily, and seldom is, artistic taxidermy.

The taxidermic artist, the acceptable one at least, if not competent to design subjects for representation, must be able to execute the designs of others. The prerequisite of every group must be the illus-

tration of some fact, the teaching of some lesson, and, in order that no error may be conveyed, it is important that it shall contain no incongruities however trifling. A bird from Florida, therefore, would not be placed in a cranberry bog or upon a spray of arbor vitæ, but among southern aquatics, on a magnolia bough, a branch draped with "Spanish" moss, or with other accessories as characteristic as itself of the locality which it inhabits. The position or attitude of every specimen must be carefully studied in order that it may express distinctly a characteristic of the species.

The taxidermist who is competent to do the work now required by the more advanced museums must know far more than the relaxing of dried skins, the cleansing of soiled plumage, wiring, and other mere technical details of his work. He must even be more than an artist—he must be something of an ornithologist. For example, he must possess the elementary knowledge of birds that would prevent him from mounting a swift perched, like a swallow, upon a twig; from mounting a humming bird with its wings crossed or laid over the tail; from raising or arching the tail of a jungle cock as he would that of a dunghill; he would not think of compressing the body of a duck or flattening that of a rail; and he would thus be particular about hundreds of other things apparently trifling to the untrained observer, but really of great significance and importance. He must understand modeling in wax and other materials in order that soft parts which shrink or distort in drying may be reproduced permanently in their natural form, and he must be able to paint skillfully, so that parts which fade or become discolored may be restored to the natural hues of the living bird. Combined with the knowledge and ability to do all these things, he must have that fidelity to truth which will forbid him painting a wood duck's bill yellow, or giving it blue eyes, or otherwise "taking liberties" with nature. In other words, if he does not know what to do in specific cases, he must not supply the deficiency in his knowledge by guessing and thereby at the same time deceiving the uninformed and shocking those who happen to detect the fraud.

The acceptable taxidermist will not confine his studies to the workshop, but will study the subjects of his art in life wherever he has the opportunity. He will make free use of the camera whenever and wherever the opportunity offers; will make careful memoranda on the colors of parts which change in hue after death, or, better still, color sketches of them. In short, he will neglect nothing which may add to the excellence of his work.

The ideal described above is not impossible, for he does exist; but such are few in number—fewer, certainly, than the fingers on one hand. Nor are the qualifications specified unnecessary, for only those who possess them can hope for continuous employment, unless in the shop of the ordinary bird stuffer or some museum of the lower rank.

BIRDS.

By Dr. R. W. SHUFELDT.

In the system of classification adopted by the World's Columbian Commission, the exposition of material pertaining to the science of Ornithology was provided for in a general way by the establishment of class 230, of group 34, wherein the intention was announced that "Birds of all countries, alive and as stuffed specimens" would form a part of the world's exhibit at Chicago. Provision was also made for this important science by the convening of a congress on birds, under the auspices of the world's congress auxiliary, which was designated as the "Division of Ornithology." Many ornithologists of distinction and world-wide reputation were present at the convention, and many papers were there read which were of great value to the progress of ornithology, but as all this, and more besides, will be incorporated in the history of that congress, it does not properly fall to my duty to have anything to say about it in this place.

Confining myself then more strictly to that part of the subject as set forth in the title of this report, I would, in the first place, invite attention to the nature and character of the ornithological exhibits at the Exposition. In one way or another these have been, in a number of cases, already alluded to in my report upon taxidermy.

Many foreign countries, as those of South America, and the nations of Europe and elsewhere, submitted with their general exhibits cases of mounted birds and mammals of various pretensions. Some of them also exhibited collections of skins of birds, as for example the rather interesting collection sent on by Guatemala and one or two other countries. In this matter a similar action was taken on the part of a number of the States and Territories of this country, and a majority of the State or Territorial exhibits attempted, among other things, to show the most characteristic forms and species representing their respective avifaunæ. In most cases this was but feebly accomplished, while in others, the very indifferent character of the taxidermical methods employed, detracted in a marked manner from those more or less praiseworthy attempts, which, but for it, might have been to a greater degree successful.

Occasionally we met with an instance where a few living birds formed a part of the exhibit. Manitoba may be cited as an example,

and the value of her wonderfully interesting collection was materially added to in this way.

Another class of exhibits of ornithological material were those where one or more private individuals submitted a case of mounted birds, or even single-mounted specimens, to be placed in any suitable connection on exhibition. For a number of reasons these, as a rule, were of but little scientific value, though, if not examined from this standpoint, they often lent a pleasing effect to the general appearance of a number of the exhibits that possessed them. But we must not so far digress here as to be guilty of passing into the realms of "decorative taxidermy," a subject quite apart from "scientific ornithology," to which this report is to be more especially devoted.

Prof. H. A. Ward placed on exhibition a large scientific collection from his famous establishment at Rochester, N. Y. In the paleontological part of this there were a few specimens of interest to the general student in ornithology, but there were a great many more in his mounted collection of existing forms, and especially in the series of mounted skeletons of birds, which he exhibited in connection with the latter. The placing in museum cases of well-mounted types of bird forms, with accurately articulated skeletons of the same on stands near them, is a most admirable plan, that should be more universally adopted, and is largely adopted by the zoological museums of such institutions as the University of Cambridge, England, and the American Museum of Natural History, in New York City, and some few others.

At the Columbian Exposition, however, the greatest interest for ornithologists centered about the collections placed on exhibition there by the Smithsonian Institution and the United States National Museum, of Washington, D. C. The specimens composing these were not only very fine examples of the taxidermic art, but they were instructive from a scientific point of view. In the main, ornithology was here represented by single mounts of birds and also by a large number mounted in groups. These latter had been selected from many parts of the world, and in each and every instance were designed to show, in one way or another, some of the peculiar habits of the bird forms that composed them. Not only were the specimens themselves excellent pieces of work, but the accessories were equally good, and the natural haunts and surroundings had been reproduced with a fidelity to nature, in a manner which is rarely if ever excelled. We met with flamingoes and their nest; with jacanas skimming over the lily pads of a placid pool; with snowy-white ptarmigans disporting themselves upon the surface of the glistening snow; and a great many others of a similar kind, too numerous even to name, much less describe, in detail. Scientific ornithology had not been forgotten in another direction in this admirable Government display, for we found also beautiful models showing the various stages of the embryonic development of birds; we found the avian skeleton disarticulated and exhib-

ited in a way best calculated to illustrate the question of serial homologies of the various bones as compared with the corresponding ones in the skeletons of other vertebrates; and finally, in connection with fine mounted skeletons of ornithic types, we found an ingenious series of models of skulls, one of a bird being among the number, in which the individual bones of that part of the osseous system had been painted in different colors, so as to show the existing uniformity in plan of structure.

In some of the exhibits, as for example the one which belonged to the German Empire, the progress and the present status of a number of the sciences were shown by placing upon exhibition the published works in any particular instance, as well as by hanging upon the walls examples of the most recent advances in the art of illustration. These engravings or photographs or the numerous modern methods of reproducing the photographs for plate work showed how science is taught in the schools by such means; they showed the manifold means at our disposal for illustrating the natural objects to which the biologist directs his attention in nature. This could have been done by similar means for the science of ornithology, for the progress of that science during the last century, as exemplified in its literature, has been very great, even in this country. From the dawn of history to the present time, as our knowledge of the structure or morphology of birds has widened, ornithological classification has from time to time been very materially altered and improved, and our art of illustrating the forms of birds and everything that pertains to them has also kept pace with this knowledge. At any great exposition all this can be easily shown by exhibiting copies of ornithological publications, illustrations, or indeed anything showing the advances in our knowledge in the directions just indicated.

Next in order there should be presented as much as possible of our knowledge of the origin of birds in time, and the most recent discoveries along such lines. The well-known fact that birds are merely in their organization an aberrant reptilian type, showing extreme modification, can very satisfactorily be shown by models, fossils, casts, and drawings of the various extinct birds known to us. These should be properly compared by similar means with extinct and existing reptiles of genera and species best calculated to demonstrate the alliance. Material of the greatest interest and highest importance to accomplish this end is in our possession, and however well its significance may be appreciated upon the part of the scientist, is no valid reason why it should not with great care and system be duly exhibited at each and every great international exposition the world is to see. In the present brief report we can not be expected to do more than to throw out the suggestion just made, as the enumeration of the fossil and existing species of animals it would require to illustrate it, would quite exceed our space limits, and so be impracticable. Another series

should be exhibited, which will make clear the fact that, as a great group, existing birds must now be considered as a class Aves, which by the elimination, from one cause or another of myriads of forms in geologic time, have at last become, as a natural group, wholly differentiated from the reptilia. By actual material, and by models showing the anatomical structure of the highest types of existing reptiles, and the same for the more lowly types of existing birds, this fact would not require a great outlay for its demonstration. The series should stand next in order, after the first one suggested, or that part of the exhibit which demonstrates the ancestry of birds.

As for the morphology of this class, which should next be exhibited, it can best be done by models, anatomical manikins, and diagrams. Avian embryology is now very satisfactorily shown in a series of models of eggs composed of wax, tissue paper, and other materials. These exactly imitate eggs at various stages of incubation, and are opened upon one side to show the development of the chick within at those stages. As I have already remarked, there was an exhibit of this kind in the Government collection, and my impression is that it was of French manufacture. Much of the anatomy of the "soft parts" of existing avian types can now be most perfectly reproduced by the various plastic methods. Of course for the osseous system there is nothing better in most cases than the real skeleton itself, and an example series of these should be shown, both articulated and disarticulated.

From the exhibition of models, etc., showing the complete development of an ordinary existing bird, we should pass to cases showing comparative morphology, within the class and the application of it to the science of avian taxonomy, or the classification of birds. Following in natural sequence with this latter exhibit we should find a series of cases to contain representatives of families of the main groups of the class as they are understood to be divided, and at the same time allied to each other, according to the views of the best authorities on the subject. About 20 such cases would answer, as frequently 2 or 3 groups could be displayed in each case—they being horizontally divided by a shelf at the middle after the usual plan adopted by most museums. As an example of this, we may select the case containing the flamingoes. It should be made to contain a pair of those birds and their nests, while in the upper section of it should be placed a perfect articulated skeleton of one of this species, with the inner surface of the solid back of the case hung with good drawings showing other structures in their anatomy, especially those parts which have proved to be of the greatest classificatory value. On either side of this case should be another like it, the one to contain the Herodiones and the other the Anseres; and these should be filled up in the same manner. Moreover, in these cases, we should be careful to exhibit in their proper places the so-called "outlyers" among

birds, or, in other words, the more or less generalized types which appear to have relationships with a number of groups. For instance, among the Herodiones we would find Scopus, and among the Anseres a specimen of the horned screamer. A skeleton of each of these forms would appear, with other systems of their anatomy, so far as known, in drawings. Printed descriptive cards should be attached to each of these cases, giving all the necessary information according to the most recent views accepted by those ornithologists best known to the science, while the walls of the hall of this exhibit should be hung with large charts setting forth much additional information. At least a half a dozen of these charts could be devoted to views of the "avian tree," with its horizontal sections, and others to mercator projections of the whole world, showing the distribution of the class in the zoo-geographical areas and their minor divisions, as well as the total number of species of birds known to exist at the present time, and other matters of importance to ornithology as a whole. Special cases could be devoted to the exhibition of such subjects as "protective mimicry," "hybridization," albinos, dichromatism, avian pathology, economics, and breeding as applied to birds, or as the class furnishes examples of the same. Examples, too, of migration (shown upon charts), and the question of song, causes of extinction and increase, eggs, and the molt constitute other matters that should not be overlooked.

In conclusion, I would say that nothing more has been attempted in this brief sketch beyond the setting forth how the science of ornithology should be represented at an international exposition of any magnitude, and pointing out to what extent such a scheme was perfected at the World's Columbian Exposition at Chicago in 1892. History, I fear, will show that it fell far short of what it ought to have and might have been. Organization is the great secret of achievement in such matters, and where the announcement of the intention to have an international exposition is made several years in advance of the time set for it, the only plan for ornithologists to adopt is to hold, as soon as possible after that announcement, an ornithological congress, and have it refer certain departments of the science to the various ornithological bodies to have them undertake the exhibition of them.

In this way such fields of research as the geologic history of birds, their evolution in time, their geographical distribution, literature, taxonomy, and like departments would be fully illustrated as set forth above, and as a result, when the exposition came to be a fact the science would be represented in a manner worthy of the important place it holds in general biology, and according to methods best calculated to exhibit its advances during epochs that have passed in its history and which lead up to its status at the time of the holding of the exposition.

PHARMACY.

BY

J. D. HUMPHREY.

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PHARMACY.

By J. D. Humphrey, M. D.

On the northwest corner of the gallery floor of the manufactures building, liberal-arts department, were located the main exhibits relating to pharmacy, although there were many pharmaceutical preparations scattered over the entire building and many in the agricultural hall. The best displays were made by Americans, yet there were some fine displays in the French and the British sections, and one very creditable display in the German. It was a matter of some surprise and regret that the two great countries, Great Britain and Germany, that lead the world in the production of fine chemicals, and whose exhibits of these goods elicited such admiration and applause, had such poor and so few pharmaceutical preparations on exhibition. While the displays in the United States section were not as numerous as they might have been, many firms who had made handsome displays and won many medals and diplomas at previous worlds fairs were conspicuous by their absence; nevertheless, the exhibits as a whole were very creditable and showed much taste and skill in their arrangements. The pharmaceutical displays were more attractive to sightseers than any other class of exhibits in the liberal-arts department; they were of such a character as to attract the attention and admiration of physician, pharmacist, and layman alike. The physician stopped to wonder at the progress made in the practice of "elegant pharmacy," while the pharmacist looked on in amazement and seemed to anticipate that the time is coming when the dispensing of physicians' prescriptions by the pharmacist will be exceptional and his professional dignity lowered to that of a tradesman simply dealing out to the patient ready-made prescriptions. From the character of some of the exhibits we were convinced that there are manufacturers catering only to the physicians, doing his thinking, diagnosing his cases, making his prescriptions, and, I might add, killing his patients; but this class of exhibitors were few—the great majority were firms of responsibility whose goods have a national reputation for purity and excellence. One fact of great importance in relation to the future of pharmacy is manifest, and that is the marked tendency in the present day to the use of what might be termed "ready-made perscriptions." Almost every exhibitor had a supply of these ready-made prescriptions, called "elegant pharmaceutical preparations," on hand; many of them

protected by letters patent or trade-mark. These proprietary specialties are nothing more than patent medicines in disguise, and the physician who is gulled and humbugged into prescribing them by the dulcet song of the drummer, or the flaming advertisements of the manufacturer, simply turns over his patient to the charlatan and quack; he robs the druggist of a legitimate profit and reduces him to the level of a tradesman and insinuates, at least, that the druggist is not competent to compound his prescriptions. In these progressive times the physician too often forgets the great purpose of his profession and endangers the life of his patient by prescribing these ready-made prescriptions and giving importance to manufacturers' compounds; and the druggist anxious for trade and wishing to keep in with the physician, and wanting to appear as up with the times, lays in a supply of every nostrum that comes along and thereby lowers himself as a vendor of patent nostrums. This state of affairs, the druggist says, has been brought about by the physician, and the physician says the fault rests with the druggist in not keeping up with the demands of practical pharmacy. The trouble rests with both—the doctor is too indolent to think and the druggist too lazy to work.

The doctor prescribes elixir, bismuth, and pepsin and iron, sugar-coated pills, iron, quinine, and strychnine, and granules of morphia, and a multitude of other ready-made compounds. I am free to say I have no faith in the skill of the physician who prefers prescriptions of others to his own. There is one consideration that will always have to be borne in mind in regard to these "elegant pharmaceutical preparations," and that is the reputation of the manufacturer for putting up articles that are truly what they are represented to be. No field or profession offers such chances for sophistication as that of the manufacturing pharmacist, and the very fact of such a possibility will always help to make these compounds repugnant to the true and conscientious pharmacist. The Columbian Exposition furnished the largest and most comprehensive display of articles in the chemical and pharmaceutical line that the world has ever seen, and the greater portion of this display was located in the sections belonging to the United States, Germany, Great Britain, France, and Russia. The plea that this or that country was not fully represented or could have done better under more favorable circumstances will not count for much. It is a matter of considerable regret that that portion of the drug and chemical line in which the United States excels—the manufacture of pharmaceuticals—should have been relegated to a gallery in the liberal-arts department.

ENGLAND.

It is a well-known fact that the chemical industry of Great Britain is one of great magnitude, but the fact is not strikingly illustrated by

the extent of the exhibits at the World's Fair; and judging from the number of displays in the pharmaceutical line one would think this country stood terribly in need of manufacturing pharmacists, as there were only nine manufacturers of pharmaceuticals with displays. These were: Alfred Bishops & Sons, London, who exhibited a fine line of effervescent preparations; Thomas Christy & Co., pharmaceuticals; Newball & Mason, Nottingham, dried herbs and beer extracts; W. Ransum & Son, London, dried herbs, essential oils, and pharmaceuticals; H. H. Smith, London, chemicals; Richard Usher, herbs; Borroughs, Welcome & Co., London, who have the largest display in the British section. This last firm had a fine line of tabloids, of excellent quality and finish. They had on exhibition a case of these tabloids carried by Stanley during his African exploits, all of which were in perfect condition, showing the mode of manufacture and coating to be perfect. The tabloids for hypodermic use made by this firm were readily soluble, and as near perfect as they can be made. They also manufacture a malt extract, malt essence, and solution of cod liver oil. There were also exhibits of veterinary remedies, disinfectants, and sheep dips in this section, and one very creditable exhibit of chemical stoneware by Doulton & Co., of London.

GERMANY.

It is a matter of very great surprise that Germany had no pharmaceutical exhibit proper at the World's Fair. This country had the finest display, by far, of chemicals, which certainly was a revelation, and competent judges say it was the most extensive exhibit of its kind ever known in the world. There was only one display of pharmaceuticals, and this was chiefly a collection of vegetable drugs, extracts, and juices, but none of the so-called elegant pharmaceuticals. The absence of these preparations is due to the fact that only such of them are used in Germany as are made by the "Apotheker" himself. They are not made on a large scale, as in France and the United States, and besides the German physician does not take kindly to the many new preparations, but keeps on prescribing in the old reliable way. He seems to prefer to do his own thinking and mixing. There was only one display of pharmaceuticals; the rest of the section was taken up in exhibiting the chemical industry of Germany, about which another, more competent than I, will report.

FRANCE.

The exhibits of this country were unfortunately withdrawn from competition, and the writer had very little opportunity for making examinations and taking notes. The names of Paris and France are somehow synonymous with elegance and beauty, and the visitor who was familiar with the names of the French scientists in medicine, sur-

gery, and pharmacy was not disappointed when he visited the French section and saw the display of chemicals and pharmaceuticals of that country. France will no doubt retain its claim to be the home of "pharmacies élégantes," a term rendered still more appropriate by its exhibits, surrounded by the most exquisite products of pharmacal art, the essence and odors of its famous makers. Of the nearly half a hundred exhibits in this section a considerable portion of the pharmaceuticals indicated that the status and tendency of pharmacy in France are similar to that of the United States. The French pharmacist, like his American brother, is too much dependent upon the manufacturer for his supplies; he is more of a vendor than a producer. It was not hard to discover that in the line of perfumes France took the lead. The largest exhibit was that of Pinaud, of Paris, whose display was par excellence. His was the center of attraction to thousands of visitors, who lingered around its scented precincts. This salon was one of the gems of the manufactures building, and its treasures of musk were worth more than their weight in gold. Rose, sandal, and other precious woods were examined with infinite pleasure, and after seeing it all one ceases to wonder why the products of the Parfumerie Ed. Pinaud have such a reputation the civilized world over. The display of essential oils and crude perfumes was an attractive one, and the collection of different kinds of musk won the admiration of all druggists who saw it. The following firms had exhibits of finished products, all finely installed in a characteristically Parisian manner: Vaissier, Paris; Rigaud, Paris (the latter was quite lavish in the use of an atomizer upon the crowds which passed through the section); Demarson & Chetalet, Paris, perfumes and soaps; Société Hygiénique, Paris, medicated soaps and dentifrices; Raspall, Paris, perfumes, soaps, and toilet preparations; Dorin, Paris, powders and cosmetics; Lamoille & Co., Nice, perfumes and extracts; Lautier fils, Graese, perfumes, pomades, extracts, and olive oil.

[From Pharmaceutical Era.]

In the line of chemicals and pharmaceuticals probably no house is better known to the American public than that of Rigaud & Chapoteaut, of Paris, through their American agents, E. Fougera & Co., of New York. One very interesting feature of their exhibit is the display of morrhuolines, consisting of bitartrate of amylamine, dihydrolutidine, oxycollidine, morrhuine, chloroplatinate d'amylamine, nico-morrhuine, chlorhydrate de nico-morrhuine, chlorhydrate oxycollidine, bromhydrate d'amylamine, chlorhydrate d'amylamine, and bitartrate dihydrolutidine. This firm also displays a line of strontium salts prepared by the process of Paraf-Javal, apioline, liquid and crystallized guaiacol, essential oil of sandal (Santal-Midy), dialyzed pepsin, boldo-glucine, and a very complete line of filled capsules—pearls, dragées, pastilles, etc. Adrian et Cie., of Paris, is one of the representative firms in the chemical and pharmaceutical line. Their works at Courbevoie, a suburb of Paris, are quite extensive, giving employment to about 600 men. The firm has on exhibition a very complete line of well-known chemicals, and besides has many which are interesting by reason of their rarity. Of this character is a specimen of a prepa-

ration called lactose de femme, with similar specimens prepared from the milk of the goat, cow, donkey, sheep, and mare. This line of investigation is apparently of a tentative character, the exact therapeutic range of the products not being disclosed. The firm also exibits salicylamide by Denige's process, eucalypteol or bichlorate of eucalyptene, bichlorhydrates of citrene, myrtene, cedrene, and cajuputene; also digitalin, digitaline, digitaleine, digitonine, digitene, berberine, hydrastine, cotoine, eserine, nitrate pilocarpine, podophyllotoxine, picropodophylline, colocynthine, sulph. sparteine, asparagine, picrotoxine, and xanthropuccine. An adjoining case contains specimens of Deschien's soluble hemoglobine, which is also manufactured by Adrian et Cie. The French exhibit would be incomplete without an exhibit by the Solvay Process Company, but the smallness of the display is somewhat disappointing when the extensive operations of the company in France, Germany, Russia, and other countries is considered. The exhibit consists of specimens of caustic soda of various degrees of purity, hydrochloric acid, and bicarbonate of soda. Another extensive chemical manufactory is that called the Pharmacie Centrale de France, Ch. Buchet, manager, Paris. The factory, located at St. Denis, gives employment to over 500 men and is one of the largest in France. The exhibit consists of cachets with machines for making them, powdered drugs, medicated cottons, pharmaceutical preparations, nicotine, guaiacol, sparteine, terpinol, apiol, cicutine, hypnal (chloral-antipyrine), arbutine, quassine, cocaine, pilocarpine nitrate, guaranine, atropine, asparagine, caffeine, emetine, aristol, veratrine, dermatol, and salipyrine. Chassaing et Cie., of Paris, make an extensive display of pepsin in various forms, pure diastase, dietetic foods, and bidigestive wine.

RUSSIA.

The chemical and pharmaceutical display in the Russian section was not very large, and yet it was varied enough to show that the Russian chemist and manufacturer is fully abreast of the times. R. Korhler & Co., of Moscow, have a very complete display of chemicals. Broemna Brothers, St. Petersburg, make an extensive display of essences, oils, and colors. A. A. Richter, of Bucharowo, had a display of wafers and capsules of fine quality. A. Rheinherz, St. Petersburg, showed plasters, capsules, perfumes, and various chemicals. A. Rollet, Moscow, had a fine display of perfumes. Prof. Alexander Poehl, St. Petersburg, made a handsome display of pills, filled capsules, and sterilized solutions of cocaine muriate, pilocarpine mur. ergotini, and spermini-phoehl.

JAPAN.

In matter of education, engineering, mechanics, and sanitation, the Japanese made a showing which compared favorably with any other country, and as to their characteristic pottery they beat the world—but they had very little of interest to the druggist. There were some fine specimens of Japanese camphor, refined flowers of camphor, one-half and one ounce blocks wrapped in tissue paper or tin foil; three or four samples of saccharated pepsin, U. S. P.; licorice root, valerian, cinnamon bark, and cantharides, a few native essential oils, and a host of tooth powders constituted the pharmaceutical products on exhibition.

Other foreign countries made very creditable displays in other lines,

but had very little of interest in a pharmaceutical way. Mexico had more entries, perhaps, than any other country, but they were of a proprietary character and elicited very little attention. Spain had some fine specimens of oils, extracts, and bay rum, and had many preparations with a strong suspicion of patent medicines. Costa Rica had an extra large display of medicinal plants, resins, gums, crude rubber barks, coloring madders, dyestuffs, wines, liquors, animal oils, mineral waters, etc. These were well displayed in large cabinets, but the containers had no labels or numbers and the pharmacist had to be content at guessing at the contents.

UNITED STATES.

The pharmaceutical exhibits in the United States section were very much greater and more artistically arranged than those of any other country. Of the 35 exhibits in group 87 of the department of manufacturers, and which have been classified as "chemical and pharmaceutical products," there were 17 firms displaying perfumery, soaps, and toilet articles, 4 manufacturers of essential oils, and 3 glycerine manufacturers, the remainder being general chemical manufacturers. The perfumery and toilet articles display as a whole was quite creditable, although not in such a luxurious style as the same class of exhibits in the French section. Ladd & Coffin, of New York, were equally as lavish with their special odors in supplying the public as was Pinand. This firm had a very attractive display; their goods are of superior quality, put up in attractive style, and have a reputation for delicacy of odor, lasting fragrance, and true to name. Theo. Ricksecker had a very handsome display of his popular odors. The products of this firm were the only odors allowed for sale on the Fair grounds. There were many other displays in this line that deserve special mention, but as I am requested to write up the pharmaceutical display proper I will pass on to the American pharmaceutical display in the gallery. Here we find a certain class of products in which there is apparently very little competition from our foreign brethren. From the evidence presented at the Columbian Exposition the United States stands at the head in the business of pharmaceutical manufacturing. There were 28 firms having exhibits of this character in the gallery referred to, nearly all of them being elegantly installed, showing a range of products which covers nearly every want of the modern drug store. Here could be seen what great improvements had been made in the last decade in pharmaceutical manufacturing, and the mighty achievements of the manufacturer. Here the applications of chemistry to medicine are shown in the splendid exhibits of manufactured drugs. Powders, tablets, and pills abound, and deserve special mention. Great improvements in the manufacture of many forms of antiseptic dressing, plasters, and the

like could be noted, but the improvement in no line of pharmaceuticals has been so great as that of the digestive ferments. In the production of such articles as pepsin, pancreatine, and other high digestive ferments, Swift & Co. and Armour & Co., both of Chicago, easily lead the world. To make a pepsin so that one grain will digest 3,000 grains of coagulated egg albumen in a given period of time, and also be odorless, palatable, and aseptic, is an achievement which any chemist might well be proud of having accomplished. It is proper and fitting to accord some recognition to the pharmaceutical chemists who have placed before the public such articles of merit as come from the laboratories of these two firms.

SWIFT & CO.'S BEEF EXTRACT.

Swift & Co. are manufacturers of that justly celebrated brand of beef extract and fluid known as Swift's pure beef extract and beef fluid. These goods are made by a process owned and controlled by Swift & Co., which consists in extracting all the strength, flavor, and nutrition contained in finely chopped fresh lean beef by percolation with ice-cold water, and afterwards evaporating the juice thus obtained in vacuum at a very low temperature. It is essentially a cold process, and beef extract and fluid made by it have many advantages over the old crude processes in strength, flavor, and solubility.

Pepsin.—The manufacture of this article, whose medicinal value is universally acknowledged, has within the past few years gravitated to the source of supply of the raw material, until to-day nine-tenths of all the pepsin used in the United States is made in the laboratory of the Chicago packers, with obvious and gratifying results in an improved and more desirable article. Swift & Co. recently built a laboratory for the manufacture of this product, in which all that money and human skill could do has been done to make it perfect, with the result that to-day Swift's silver scale pepsin has gained for itself an enviable reputation by reason of the beauty of its appearance and its strength and purity. Pepsin is made by the Swift process from the inner lining of hog's stomachs, which, after being thoroughly cleansed, are put into extracting crocks where the peptic principle is extracted, after which it is dried on shallow plates which are placed on racks in a drying room through which is circulated a hot-air blast at a temperature of about 120° F. Pepsin is a valuable remedy for dyspepsia and other forms of indigestion.

Pancreatin.—Swift & Co. are also large manufacturers of this article. Commercial pancreatin is sometimes spoken of as pancreatic extract. It is a mixture of bodies in more or less variable form, and contains three ferments, two of which are of great importance. It acts on starch, converting it into dextrin, and on fats, which it emulsifies. It acts only in neutral and alkaline solutions, and when taken by the mouth it should be taken some time before meals in order to

give it some time to pass through the stomach before the process of digestion of food causes the stomach to become acid. Pancreatin is a comparatively recent discovery, and until very recently there has been but little manufactured of any medicinal value; now, however, the laboratory of Swift & Co. is turning out an article which contains all the digestive and emulsifying principles of true pancreatic acid. It is made from the pancreas gland, commonly called liver sweetbread, and its manufacture is much the same as pepsin.

Rennet.—Scale rennet and rennetine are other products of the Swift laboratory, and are made from the stomachs of young calves by about the same process which is used in making or manufacturing pepsin. One grain of Swift's rennet scale will coagulate 1 pint of milk. It is largely used in diet kitchens and hospitals for making junket for invalids.

ARMOUR & CO.

Ten years ago so little was known about pepsin that it is scarcely worth recording. The United States Pharmacopœia of 1880 recognized as pepsin an article which would digest 50 times its weight of coagulated and disintegrated albumen. The revised Pharmacopœia of 1890 (issued this year) raises the minimum standard to a pepsin which will digest 3,000 times its weight of coagulated egg albumen, and Armour & Co. can safely claim to be the pioneers and the chief instruments in bringing about the standardization of the article in its purity. The pepsin produced by Armour & Co. is nonhydroscopic, almost odorless, freely soluble in water, and of a digestive power from 1 to 3,000 to 1 to 6,000. They had on exhibition pepsins ranging to 1 to 25,000, but these were merely to show what could be done in their laboratory. The one hundred minute test for pepsin originated with Armour & Co., while the method of testing pepsin that was adopted in the United States Pharmacopœia requires six hours. The products of the laboratory of Armour & Co. are limited to digestive ferments in their various solid and liquid forms, used as remedies, surgical solvents, and for predigesting foods. It was the good fortune of the writer to visit the laboratory of Armour & Co., which is perhaps the largest of the kind in the world, and is equipped with the best and most original apparatus and machinery, especially constructed for carrying out the various processes in the shortest time possible and under the most favorable conditions. These advantages of location, machinery, original processes, and ample capital have, to a great extent, taken this class of goods from the hands of those unfavorably located and with poor facilities, and have elevated them to a standard of excellence seldom attained.

W. R. WARNER & CO.

W. R. Warner & Co., manufacturing pharmacists, of Philadelphia, had decidedly the largest display of sugar and gelatin-coated pills in

the Exposition. They were of many shapes and colors, being round, flat, oval, and oblong, and white, pink, blue, yellow, and black; all of perfect finish, accurate in composition, freely soluble in water, hot or cold. A case of pills made twenty-seven years ago were on exhibition and found to be in perfect condition, which fact exemplified the permanence and keeping qualities of Warner's pills. This firm had on exhibition also a full line of elegant pharmaceutical preparations, consisting of compressed tablets, hypodermic tablets, fluid extracts, tablet triturates, elixirs, sirup, and effervescing salts. The latter were perfect in granulation, superior effervescing qualities, permanent and accurate as to composition. The specimen of Aloin exhibited by Warner & Co. was of a superior quality, being perfectly free from resinous extractive matter, also odorless from the odor of aloes, and of a beautiful bright color, superior to any we have ever seen, either imported or domestic. This firm was organized in 1856 and are the pioneers in the manufacture of sugar-coated pills in the United States. They have taken medals at all world's fairs (15 in number) in which they made displays. They have branch stores in Chicago, New York, and London.

TILDEN & CO.

This firm exhibited a well-selected line of fluid and solid extracts, elixirs, wines, sirups, pills, solid and powdered extracts, tablets, tablet triturates, and a few specialties such as elixir, iodo, bromide, calceum compound, ferwein, beef, iron, and rye and maltopesin. We believe that it is but right and proper to say that the high standard of excellence in strength, purity, and finish of the product of this firm is just matter for congratulation, the preparations having maintained their character in every test to which they were subjected.

SHARPE & DOHME.

In a tastefully arranged booth and in the dignifiedly modest manner that has for so many years characterized the business life of the firm, Sharpe & Dohme exhibit their well-known products. With no attempt at gorgeous display, but with that earnestness of purpose which is the privilege of modest merit they have presented representatives of their large and varied line which, taken as a whole, do them great, because deserved, credit. Not only have they shown real pharmaceutical progress in their line of medicinal fluid, solid and powdered extracts, soluble gelatin and sugar-coated pills, hypodermic tablets, and other products, but they have produced what has been officially recognized as the best pepsin. We refer to Webber pepsin, S. & D., guaranteed standard 1:6,000. This high-grade digestive ferment was exhibited in a pyramidal case with three compartments, in each of which was shown one of the three forms—granular, scale, and powdered—in which this pepsin is offered. As an evidence of still further advance in this

field of study, this pyramid was crowned by two graceful globes, one containing a beautiful display of a 1:8,000, the other an equally attractive exhibit of a 1:10,000 scale pepsin, both produced by the Webber process. We are assured that a 1:30,000 pepsin is a pharmaceutical possibility, although, as a commercial entity, 1:6,000 seems to be the most desirable standard. This is just double the United States Pharmacopœia standard, which is 1:3,000. Ergot, that desideratum of the obstetricians armamentarium, is fitly represented by ergotole, S. & D., of which we are assured each minim represents 2½ grains of the best Spanish ergot in a palatable nonnauseating liquid form. The courtesy of their genial Chicago manager, Mr. Charles E. Matthews, and his perennial enthusiasm in the future of the house he so capably represents, is infectious, and the memory of our official visit to Sharpe & Dohme's booth is both pleasant and lasting.

JOHN WYETH & BRO.

One of the most pleasing and interesting exhibits in the pharmaceutical department was that of John Wyeth & Bro., of Philadelphia. This house enjoys a most enviable reputation for the superior character and quality of its products. It is among the largest and most noteworthy of our chemical and pharmaceutical manufacturing establishments. This firm and its products are as well known in the principal cities of the world as to every drug house in this country. It was established in 1861, and was the pioneer in what is termed "elegant pharmacy." They were the first to introduce what is to-day the most popular mode of administering medicines—in pill form. Their compressed powders into pills, hypodermic tablets, lozenges—all compressed from perfectly dry powder—are marvels of accuracy, of beauty of finish, and bear the most critical examination. Their products—fluid extracts, elixirs, wines, and sirups, etc.—are fully up to the standard, and the beauty of the finished product is but a proof of the rapid strides made in the progress of pharmacy. It is but just to say that the process adopted by the United States Pharmacopœia for making fluid extracts originated with this house. This firm had on exhibition also digestive ferments, liquid malt extract, liquid beef juice, and absorbent cotton, all of excellent quality. They employ 400 hands, male and female, and have over 300,000 square feet of floor space in their plant.

BURROUGH BROTHERS MANUFACTURING COMPANY.

This firm had a very extensive assortment of their products on exhibition, consisting of fluid and solid extracts, elixirs, sirups, powders, pills, granules, tablets, triturates, and hypodermic tablets, etc. The term "manufacturing pharmacists" may mean much or it may mean little, depending to a great extent upon the firm using the title. In the case of Burrough Brothers it means a great deal, for the products

from the laboratories of this firm cover nearly the whole range of wants of the retail pharmacist. The multitudinous wants which are supplied by such enterprise as is shown by Burrough Brothers is evidence that they are abreast of the times. The products of this house are well and favorably known to every druggist in the land. Their fluid extracts are too well known to require special mention, but we do feel that something should be said of the excellent line of phamaceuticals which, as to purity, beauty of finished product, accuracy of dosage, and skill displayed in their manufacture, could not be excelled. Their tablets and hypodermic tablets were elegant specimens of the pharmaceutical art—accurate and most easily soluble.

MELLOR & RITTENHOUSE COMPANY.

The display made by the Mellor & Rittenhouse Company consists of a plate-glass case containing manufactured products of licorice root in all its forms—sticks of all sizes, lozenges, and powdered—and some beautiful scales of ammoniacal glycyrrhizin. The extract of licorice exhibited by this firm was the purest I have ever seen, either imported or domestic; it was entirely free from grit or other adulterants and almost wholly soluble. The yearly output of this firm is from 3,000,000 to 4,000,000 pounds of extract of licorice. Although a great deal of this extract is disposed of to the drug trade, yet the great bulk goes to flavor chewing tobaccos.

HARVEY & CO., SARATOGA, N. Y.

This firm had a very creditable display of pharmaceuticals, consisting of compressed tablets, tablet triturates, hypodermic tablets, elixirs, sirups, tinctures, and extracts. This firm makes perhaps the largest line of tablet triturates of any other manufacturer, except perhaps the H. K. Mulford Company. They cater to the physician, and look only to him for a market for their preparations. Their goods are fully up to the standard and show much skill in their manufacture. Their hypodermic tablets deserve special mention. They are very soluble and are sufficiently well made to bear transportation and yet are very friable.

FAIRCHILD BROS. & FOSTER.

Fairchild Bros. & Foster had one of the most pleasing exhibits in the liberal arts department. Their exhibit was entirely of their well-known digestive ferments, embracing every product of the calf rennet, pig stomach, and the pancreas, both pure and in proper combination for medicinal use. Fairchild's pepsin is known all over the civilized world for its high digestive power and comparative freedom from bad odor. Many of the preparations exhibited by this firm were originated by them and are not made by any other house.

FREDERICK STEARNS & CO.

This was a very handsome and tasty exhibit and a very pleasant place in which to pass an hour now and then. It was the most "home-like" of all exhibits, and the very pleasant greeting by Mr. Stearns, jr., and Mr. Penrose Jones made one soon feel at "at home." This firm exhibited for competition their elegant line of perfumery and toilet articles in plain, ornamental, and cut-glass bottles. The reputation gained by this firm on their perfumery was manifest by the request for their leaders—crab apple, white rose, heliotrope, four roses, and amorita. This firm exhibited also a full line of pharmaceuticals, consisting of fluid and solid extracts, elixirs, sirups, wines, powders, pills, compressed tablets, and triturates. These goods stood every test applied and maintained the reputation already enjoyed by the firm for "purity." The uniformity of size, superior finish, and freedom from pin holes in the gelatin-coated pills attracted much attention, this latter feature being original with this house by a process peculiarly their own. They also displayed the various preparations of Dike's pepsin, a very fine article of high digestive power and almost odorless. This firm were the originators of the "Nonsecret" medicines in 1876. Their idea was to relieve the druggist from the patent medicine difficulty and to furnish him with a line of preparations that would replace the patents. The venture was a success from the beginning, as evidenced by the large and increased sales of these goods. F. Stearns & Co. have introduced many very excellent preparations to the trade, the most popular and deserving being cascara aromatic and wine of cod liver oil with peptonate of iron.

Seabury & Johnson and Johnson & Johnson made very creditable displays of plasters, ligatures, bandages, absorbent cottons, and various other important adjuncts to modern surgery.

CHARLES MARCHAUD.

This exhibit consisted of a show case of polished oak containing a pyramid, upon which were displayed the products of the laboratory of Ch. Marchaud, viz, peroxide of hydrogen and glycozone, both in marketable packages of 4, 8, and 16 ounce bottles. The peroxide of hydrogen, which is so favorably known as a powerful antiseptic and destroyer of germs, bacteria, and microbes in the human system, is a definite chemical compound. H_2O_2 can be applied locally, or taken internally, with perfect safety. Glycozone is a stable compound resulting from the chemical reaction which takes place where chemically pure glycerin is submitted under certain conditions to the action of fifteen times its own volume of ozone under normal atmospheric pressure at a temperature of 0° C. It is used in all cases where an antiseptic and stimulant is indicated. These preparations, and especially

the peroxide of hydrogen, have been before the medical profession for some years, and have gained the general indorsement of the profession as to their purity and effectiveness.

H. K. MULFORD COMPANY.

This firm had a most attractive display of tablets and other specialties on exhibition. The compressed tablets and tablet triturates and hypodermic tablets exhibited by this firm were marvels of beauty, accurate as to dosage, and easily friable, being made without gum or other foreign material, except pure milk and sugar, and hence are freely soluble. Vaginal tampons made of wool, medicated or plain; digestive malt extract with small percentage of alcohol (3 per cent) of good quality, and improved vial cases for physicians were exhibited by this firm and awarded prizes.

UPJOHN PILL AND GRANULE COMPANY.

The exhibit of the Upjohn Pill and Granule Company presented a unique and attractive appearance, and gave abundant evidence of the characteristic push and energy of that progressive house. One of the most striking features of their exhibit was a large and attractive display of quinine pills in bulk. This consisted of 3,500,000 2-grain quinine pills contained in a large plate-glass tank, probably the largest bulk exhibit of pills ever displayed. Reducing the matter to figures, we find that the pills in question contained 16,000 ounces of quinine sulphate, and represented a value of about $7,000. Resting on this tank was an elaborate mahogany and plate-glass case, containing a large and artistically arranged assortment of pills of varying kind and color, displayed in handsome glass containers. The well-known friable and soluble condition of pills manufactured by the Upjohn Pill and Granule Company has ever been an irrefutable argument in their favor. The phenomenal growth of their business and the general adoption of their line of goods by the professions of medicine and pharmacy have been due to merit as well as push. The process of reducing dry powders to pill form without the aid of excipient, and their manner of coating, is original with this house. They manufacture a full line of pills, and make all the known standard formulæ by their peculiar method.

The Albany Chemical Company had a general line of pharmaceuticals and chemical preparations. They exhibited large quantities of their chloroform, both commercial and purified, made by the acetone process.

The Ale and Beef Company, of Dayton, Ohio, had a pyramid of their specialty—liquid beef.

Thompson's Malt Extract Company had a very nice display of their malt extract and malt preparations. These goods are well known in the West, and the manufacturers have a large sale on them. They

stood every test applied and were pronounced by the jury of awards of excellent quality and possessing diastatic properties to a large degree.

Horlick's Food Company and Reed & Carmick had exhibits of their well-known products—infant foods.

The Chicago College of Pharmacy had a very elaborate exhibit. Their exhibit of drawings by Professor Goodman shows an improved method of teaching botany by means of typical drawings of plants and plant life, a great improvement over the pressed natural plants. There were 553 specimens of organic drugs displayed in glass cases. These embraced the official drugs in the United States, British, German, and French pharmacopœias. A section of the dispensing counter and fixtures showed a marked advantage in having the operating table free from the usual superstructure, the apparatus, containers, etc., being placed on an independent fixture and thus not obstructing the view of the manipulations involved in dispensing and compounding. Some rare old books, including the books of Galen, all the editions of the Edinburgh Dispensatory, the pharmacopœia of all countries, and a number of works printed in the sixteenth, seventeenth, and eighteenth centuries were on exhibition.

JOSEPH BURNETT & CO., BOSTON.

One of the most artistic and attractive of our domestic exhibits in the great manufacturers building was that of Joseph Burnett & Co., of Boston. This firm had on exhibition their flavoring extracts, cologne water, smelling salts, and their wonderful color pastes. The flavoring extracts of this firm are universal favorites and are perhaps more widely and generally used than those of any other manufacturing concern in the world. They are made of the very best materials obtainable, of fine flavor, and true to name. The cologne and lavender waters, wood violet extract, and other odors displayed are of exceptional sweetness, delicate and lasting. The color pastes made by Burnett & Co. are simply wonderful productions of the art of chemistry. They are freely and perfectly soluble in alcohol, water, or milk, odorless, tasteless, and perfectly harmless. They are made specially for confectioners, bakers, ice-cream manufacturers, and housewives; are put up in various sizes to suit the trade. The reputation of this firm for integrity and honesty of purpose is known the world over and their goods are universal favorites.

PHOTOGRAPHY.

BY

C. T. STUART.

1363

PHOTOGRAPHY.

By C. T. Stuart.

As a member of the jury of awards, I respectfully submit that the art and science of photography, which to-day counts but a half century of existence, has taken strong hold upon the affections of all the people who compose the nations of the world, which rests upon the fact of its influence so potent in human sentiment, educational, refining, and elevating, and with the strongest tendency in its flight of always soaring to the realms of something better. Photographic competition has always been very keen and active, with the consequent effect of enlarging ambition and stimulating individual effort.

Photography has before it, by its own component elements unique, the possibility of a great future, and is worthy of the most artistic talent, who shall properly represent her capabilities to the countless millions yet to come. There is no branch of science and art but in which photography is every day employed. It is used by the medical man to record and prove all forms of disease; the surgeon, to record his operations and condition of patient, as a truthfully illustrated record of the facts thus shown to simplify and wonderfully aid the future treatment of similar cases; and it is plain to see that while disease is a condition more or less in the life of every individual, that this phase of photography is of permanent value for its truth-telling story. Bellevue Hospital, of New York, and all hospitals of prominence throughout the world now possess their photographical departments, and high hopes are entertained of this scientific feature in the relief of human suffering.

Photography shows a large advance since the original daguerreotype plate (metallic copper), so slow as to require the best portion of one hour in bright sunlight to produce a picture, to that of the common feat now instantaneously performed, so sensitive are the prepared surfaces to light, of accurately securing in softly diffused light most swiftly moving objects, such as the modern express trains, trotting horses, etc. There is hardly an exception the world over where photography is not used in the make-up of that great educator, the newspaper, etching in line and stipple for illustrations.

It is now a common occurrence for the photographist to supply the proof and see the picture printed in the newspaper that comes to him one hour later. There seems now to be little doubt that a short period

of time may elapse before we will be sending any photographic reproduction desired from country to country over the electrical wire as is done with the telegraphic message of to-day. And how fitting will be this union of photography and electricity is apparent to all when I recall the devotion of Professor Morse to photography at the very time of his wonderful invention of practical telegraphy.

An English writer of ability and probity says:

> The international survey of the heavens is now in progress, and many thousands of negatives of the stars have already been obtained, and when this survey is complete, the present face of the sky will be known with an accuracy which the astronomers of a prephotographic age never dreamed.

Orthochromatic (color value) photography, although but in its infancy, promise great things in the near future. It is of the greatest assistance to the photographist, enabling him to more truthfully present his work. Orthochromatic plates are now made commercially in America, and there is no doubt that in the hands of first-class operators they must supplant the plain bromide plate, as the latter have the wet collodion plates. They must materially assist in finally securing photographs in the colors of nature. To Prof. H. W. Vogel, of Berlin, are we indebted for this great advance in orthochromatic photography. The three-color print is now reduced to a certainty, and is practiced in America as well as Europe, the place of its birth. In this process it is necessary to make three negatives, one for each of the three primary colors—one for yellow, one for blue, and one for red—then transfer on zinc and etch. Very much is hoped for this innovation in color work.

One of the great advances in photography is that of a celebrated French scientist taking pictures direct in all colors of nature, and more recently, even since the opening of this Columbian Exposition, still further progress has been made by other scientists of France from which much can be hoped, for there is every indication they will improve these processes. Also one of the most wonderful discoveries in connection with photography is the "tachyscope," of German origin, and perfected under the auspices and with the aid of the German Government. In this novel instrument can be seen men and animals in motion, not merely silhouettes, but photographs full of detail and modulation. Lenses and cameras are innumerable; cameras, or machines, have been perfected and connected with electricity, so that a picture (portrait or view) is taken, developed, and finished ready for delivery. Though yet producing work only in small sizes, they are exceedingly interesting.

And now for portrait photography. What a field for usefulness herein lies. As was fittingly expressed by Judge James B. Bradwell, of Chicago, in his opening address at the World's Congress Auxiliary, when he said:

> Can we fully estimate the value of a photograph of Christopher Columbus if it could be shown as he landed upon our shores four hundred years ago? Are his por-

traits satisfactory? We may admire the work of the great masters of the past and the portrait painters of the present, but no human hand or agency can equal the sunlight of the Almighty for producing lifelike and accurate features of our friends as we know them now.

In this connection a word about the exhibit of photographic portraiture. The quality of work in many exhibits is simply superb; in some cases of rather low quality, but the average of all is far above work usually shown. The four nations, England, France, Germany, and America, as usual, lead, and all are about equal in merit.

Is there any art or science upon which so much depends as photography? The astronomer, the surgeon and physician, the architect, the engineer, the minister, the lawyer, and the judge in the administration of justice, and, it may be added, this World's Columbian Exposition, are more or less aided by photography, the willing, truthful handmaid and servant of all.

In the optics of photography wonderful advance of late has been made, especially in the construction of lenses with what is known as the "Jena glass;" also the invention of Dr. Schroeder, known as the "concentric lens," which is said to be a wonderful instrument, without "astigmatism" or other defect. The "telephotographic lens" is also of recent invention, and is novel as well as scientifically useful, for with this lens, when at times for various reasons the photographist can not approach near to the subject desired, can be secured a larger plate by from three to five and a half times than the ordinary lens will produce. These lenses are made in London, but I am happy to state that lenses of American manufacture said to possess many advantages will soon be on the market.

And now, as we stand upon the conquests of the past, representing achievements progressive in all the various departments of photography, what, indeed, may we not confidently hope for in this beautiful and fascinating art? In conclusion, I feel impelled to again cite the words of our friend, the learned judge, where he asks:

> Who shall say that the camera, adjusted by the hand that feels and focussed by the eye that sees beyond, with the aid of intensely sensitive plates, shall not bring to light and view the forms of our departed friends, and thus solve the problem of immortality and life?

REFRIGERATORS.

BY

Dr. ROBERT W. HILL.

1369

REFRIGERATORS.

By Dr. Robert W. Hill.

It is a far cry from the porous jar of olden time to the finest example of a modern refrigerator, but in our methods of food preservation we employ substantially the same principles known to the ancients. Food preservation is made possible whenever the natural tendency to decay is arrested, and whatever the means adopted to secure this result, its success is in proportion to the thoroughness with which the process of change is stayed. Cooked food, hermetically sealed into glass or tin receptacles, will do wherever the preservation is to be for a long time, and is the plan for fruits. This method, however, does not meet the daily needs of the household, nor is it practicable for all things, nor will it meet the vast demands of our cities where daily immense supplies of fish, flesh, fowl, butter, eggs, etc., must be carried in stock. The only method which successfully meets the needs of our time is the method of cold storage, by which in large establishments cooled with currents of pure, dry air food may be kept in good condition for indefinite periods. The refrigerator is a modification of the cold-storage system, and just in proportion as a circulation of air, pure, dry, and cold is secured in the refrigerator will the box prove satisfactory. The refrigerator is essentially a very late invention, fully as much so as the ice machine, for it is but a comparatively few years since a satisfactory method to secure cold-air circulation was first presented to the public. At the Paris Exposition of 1867 the first really successful and economical ice-making machinery was shown, and the way made plain for cold storage on a large scale. It is true that the principles embodied in these ice-making plants had been set forth seven years before, but it required seven years of experiment to demonstrate the practical usefulness of the plans, and to secure successful and economical plants. It is not to be wondered at that the methods of household storage had been partially unsuccessful up to that time, but it is strange that in the reports of the Centennial Exposition at Philadelphia there is no mention of refrigerators. Either none was shown, or none was deemed worthy of recognition by award. Up to that time the old-fashioned ice chest was the best that was available for the household. At the Paris Exposition there were two representatives of the American refrigera-

tor, one for the household, while the other was a cold-storage room. The household refrigerator was exhibited by a Baltimore firm, and received a bronze medal, equivalent to an award of the fourth class. The cold-storage room, supplied with ice from the Alpine glaciers was used by the Department of Agriculture, and at the close of the Exposition was sold in Paris, to a Paris butcher, where it is in service to-day. For this exhibit the Wickes Company, of Chicago and Buffalo, who also exhibited at the Columbian Exposition, received recognition by a silver medal from the Commissioner of Agriculture.

Since the Paris Exposition of 1867 the manufacture of refrigerators has made rapid strides in methods of construction and in the more perfect adaptation to the needs of the household. The so-called ice chests of twenty years ago have all been relegated to the background, and few households are to be found willing to purchase even the best samples of the refrigerator of ten years ago. Since then the circulation has been made more perfect, and the methods adopted to secure insulation, as well as the many devices used to strengthen the boxes, the locks, the traps, and the material used have combined to make the best refrigerators exhibited at the Columbian Exposition almost ideally perfect. It is true there were some survivals of former years, crude and imperfect and comparatively useless, but as a group the refrigerators in the class were worthy of place in the great Columbian Exposition. It is creditable to American genius that all of the refrigerators having merit were of American manufacture, and in every respect superior to any made in other countries. The progress of manufacture in this class was fitly represented by two exhibits, one representing the earlier form of unventilated and noninsulated ice chest, while the other represented the very best form of the household refrigerator. To anyone carefully examining the Belding refrigerators, with their perfect insulation, good workmanship, and rapid circulation of cold, pure, and dry air, it seemed almost ludicrous that they should be placed for competitive examination in the same class as the ill-made and unventilated ice chest. But these two, the poorest and the best, illustrated the progress which had been made within a few years, and were striking examples of the educational advantages which in every department were presented by the Exposition.

METHODS OF CONSTRUCTION.

The construction of refrigerators to insure good results must follow along certain lines. The box must be well constructed and properly divided into compartments for ice and food storage. To economize in ice consumption there must be some insulation, and this will provide the cold air needed to preserve the food; but the interior must be so arranged that this cold air, freed of all moisture, shall rapidly circulate through all the compartments of the refrigerator, and these com-

partments be reachable in all parts for thorough cleansing whenever it is necessary to wash out the refrigerator. Added to these things the material and workmanship must be of the best, and the appearance of the completed refrigerator attractive to the eye, for in these days beauty and utility must be combined.

Almost all late styles of household refrigerators have the boxes so constructed that the ice chamber is above the food or storage chambers. There are a few exceptions to this general plan. In these the ice is either placed at the bottom or in a central compartment, with the storage chambers on each side. In one or two instances the ice chamber is at the side or end, and in the large refrigerators used by butchers and hotels the ice supply is often placed at the back and on the top of the storage chambers. The best refrigerators are all constructed of hard woods, but for the cheaper grades poplar and pine take the place of oak and ash. The sections or layers of the casing to secure insulation vary with different makes from a single thickness in some ice chests to as many as six divisions or more, as in the Belding Perfection. This method of construction assures not only strength, but a large percentage of cold to the pound of ice used. Strength is also made certain by dovetailing and bolting, which with perfectly fitted joints and a good inside lining of zinc or other metal makes the box air and water tight. The cheaper grades are coated with paint, but the better class are finished in the natural wooods with oils and varnish. The interior finish mostly used is zinc, but there are tile and galvanized-iron linings, and in one instance the food chambers are lined with glass. Where the special lining is not used the interior is finished in wood so prepared as not to absorb moisture or the taints of food. To protect the floor or lining of the ice chamber from the blows of heavy masses of ice dropped upon it the ice chamber is equipped with a rack of wood, iron, or steel, upon which the ice rests and under which the wastage escapes. The shelves in the food chambers are ordinarily made of galvanized iron or some other non-absorbing material, and are easily removable for washing. The waste water from the melted ice is conveyed away through a pipe equipped with some form of trap at its outlet to prevent the escape of the cooled air, and this trap is a very important part of the equipment of a first-class refrigerator, for if the trap fails to work properly the ice will be consumed with but little good result or the bottom of the refrigerator will be flooded with the waste water from the melting ice, to the dismay of the housekeeper.

INSULATION.

The necessity of some better protection to the ice than the wooden sides of the box became apparent as soon as the first ice chests were constructed, for the rapid waste of ice in the uninsulated boxes made

them too expensive for the ordinary family. To prevent the too rapid consumption of ice the walls were first increased in thickness, then air spaces were made in them between the outer and inner casing, and in turn sawdust packing, felt, charcoal, mineral wool, and various combinations of these methods were adopted. To determine the relative values of all these a careful test has been made, from which it would appear that walls divided by several separated air spaces present the greatest resistance to the entrance of heat or the escape of cold. But a wall containing a sufficient number of dead-air spaces would make the cases too cumbersome, and so some of the packings are generally used. By test those of equal thickness have heat-conducting power as follows, when tested separately: Sawdust, 163; loose charcoal, 140; sheep wool, 136; hair felt, 117; mineral wool, 100; compacted charcoal, 70. From this test it would appear that a wall packed with sawdust will permit 163 units of heat or cold to enter or escape, while a wall having a packing of compacted charcoal of the same thickness permits only 70 units to pass, demonstrating the fact that the compacted charcoal is far more valuable as an ice saver than is sawdust or any of the other forms of insulation. When combined with the wooden casings and with each other, it becomes comparatively easy to determine the relative values of the systems used by the manufacturers of refrigerators. From the above table it will appear that, all other things being equal, the use of some form of compacted charcoal, such as thick sheathing, combined with dead-air spaces, gives the very best results. Refrigerators which rely for insulation on a packing of loose charcoal are found to become comparatively useless after a time, as the loose charcoal settles down, no matter how firmly it may have been packed in, and thus the ice chamber is left without protection. Mineral wool, combined with the dead-air space, is a very effective insulation, and is to be preferred next to the charcoal sheathing, but unless it is put securely into position in the form of covered packets it is liable also to shake down, for the threadlike filaments of which it is composed are easily broken. Hair felt gives better results than wool felt, but both are liable to get foul in time. In the large refrigerators or cold-storage rooms used by butchers and hotels the insulation is secured in the same way as in the household refrigerators, although as the walls are thicker, the packing may be of any of the less expensive materials and still give good results.

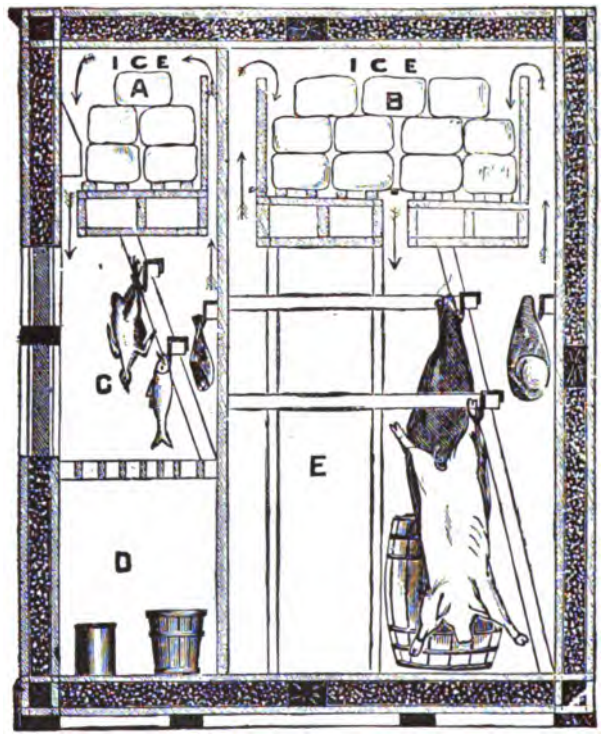
CIRCULATION.

Unless there be a circulation of pure, dry cold air, the food placed in the storage chambers of the refrigator will speedily become unfit for use, and to secure such circulation is therefore the first aim of all manufacturers. As cold air is heavier than warm air, it naturally falls to the lower level, displacing the warm air, and thus induces a move-

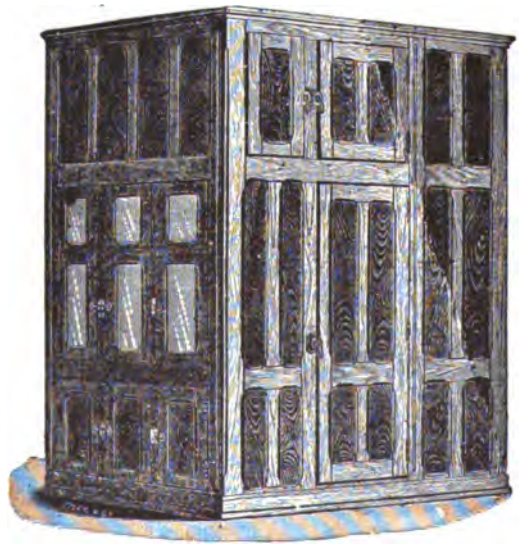
ment which will, if controlled and continued, give the desired system of circulation. In order to secure the fall of the heavier cold air, most manufacturers place the ice chambers above those intended for food or storage, and provide for the passage of the cooled air from the ice chamber by means of openings directly under the ice rack or at the ends or sides of the chamber. The warm air driven out of the provision chambers by the heavier chilled air is forced to inside or end flues, and through these escapes upward to openings above the ice over which it passes and is cooled, the ice taking out any impurities which the air may have carried up from the food chambers. Thus the air circulates over and around the ice and through the storage chambers, becoming thoroughly cooled by contact with the ice, and if the food chambers are properly constructed, so as not to "sweat," the air being deprived of moisture, by condensation on the flue surfaces, will keep dry to a sufficient extent, and the food chambers will remain pure, cold, and dry. Of course, each manufacturer claims that only his special arrangement of flues and air passages in ice and food chambers will do the work thoroughly, and that such special arrangement is the best possible, but examination reveals remarkable similarity in all. The following diagrams will show at a glance the methods of construction and circulation systems, from which will be seen the tendency of the majority of manufacturers to the use of a central air passages under the ice, and side passage in the casings for the returning air.

In the above sectional view the arrows show the direction of the air current.

All the Belding refrigerators have the compacted thick charcoal sheathing packing, combined with the dead-air space, which assures a perfect insulation, and the circulation is rapid and reaches to all parts of the food chambers, while the walls are perfectly free from moisture, thus securing the very best results. All the different styles of refrigerators made by this company are built on the same plan, the size and shape being adapted to the special uses for which the boxes are



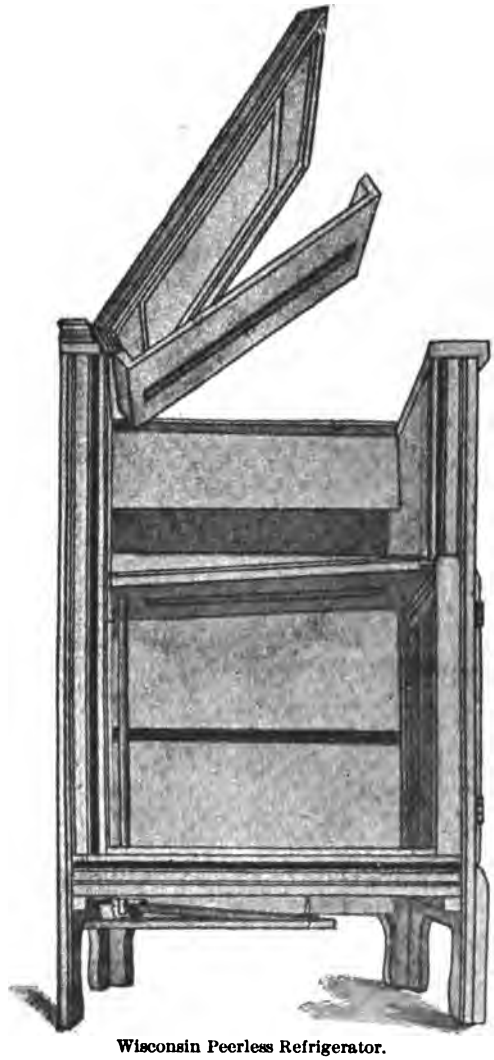
Sectional view.—A, retail ice chamber; B, wholesale ice chamber; C, retail meat department for cut meats, glass doors; D, butter, lard, and egg department; E, wholesale department for carcasses, quarters, etc.



Outside view.

designed. Their sideboard refrigerators are very handsome, and are built on the same plan with the special sideboard feature added. In the line of grocers' and butchers' refrigerators, where strength and capacity are required, they exhibited refrigerators possessing all the excellencies of the household refrigerators, and, like them, worthy of the highest commendation.

The Belding Company's Perfection butchers' and grocers' cooling room is made in sections, so as to be readily transported and set up. It is easily understood from the illustrations which follow. These refrigerators are built of kiln-dried hard wood, strongly made, and put together for hard service. They all have paneled ends and fronts, with large glass doors in the front. They are thoroughly insulated with compacted charcoal in thick sheathing, and have galvanized iron floors. The ice chambers are large, and the storage chambers are so divided as to give two departments, one for wholesale and the other for retail trade.



Wisconsin Peerless Refrigerator.

Construction showing walls of Wisconsin Peerless refrigerator and operation of cleansable flues: At left and bottom of cut is shown the manner in which the walls, doors, floors, etc., are made. To preserve the ice, first, hard-wood case; second, prepared building paper; third, mineral wool; fourth, prepared building paper; fifth, air space; sixth, inside case; seventh, zinc lining.

At left and back of cut the operation of the cleansable flues is shown. The top flue forms an inner cover or lid to the ice chamber, and assists to preserve the ice. The side flues are swung by open hinges at front

and back, and can be swung in or entirely removed to be cleansed as desired; the swinging arrangement is desirable in sizes where the ice chamber opens in front, as all that is necessary to be done is to raise the flue and wipe off the surface. The entire flue system of the Wisconsin Peerless can be cleaned readily of all impurities. The bevel lip on bottom of side flues prevents any escape of air or drip of water into the provision chamber. Underneath the floor is shown the new trap. This brings the drip to the front of the refrigerator, and annoyance from overflowing pans and inconvenience in drawing them out is avoided.

The arrows in the above cut indicate the direction of the air currents. The air in the provision chamber becoming more or less warmed by contact with the food or other articles contained therein, expands and consequently rises, taking with it the vapors and impurities from the provisions. The only course for this rising air to take is through the flues, opening from the top of the provision chamber on either side. Ascending these flues, and passing through cleansable side and top flues, the air is discharged upon the ice, passing over and around the ice, and, becoming chilled, the air seeks an outlet. This it finds at the bottom of the ice chamber, but not until it has passed under the ice and has deposited on the metal ice rack the vapors and impurities that it contained. These impurities are carried off with the water from the melted ice through the drain pipe, which has a trap underneath the provision chamber. There is no trap or loose joint within the provision chamber and the drain pipe is straight, so that it can be easily cleansed.

Sectional view showing the interior construction and circulation of the air currents of the Wisconsin Peerless refrigerator.

General construction of the Wisconsin Peerless: The outer case of all refrigerators is made of ash or oak, dried in hot-air dry kilns. The panels are in one piece and grooved into the rails and stiles, which are mortised together, making a tight cabinet. The joining and cabinetwork is good. The inner case or body is of kiln-dried, closely matched, odorless wood, lined with zinc, and fastened together with hard wood cleats which support the outside case, making a refrigerator

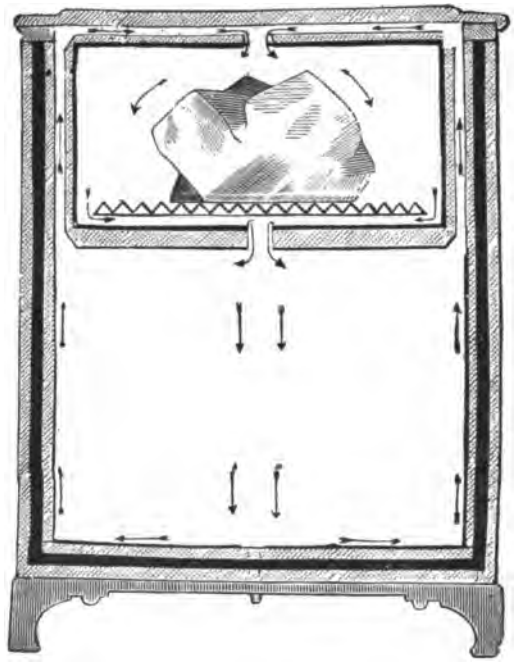
of strength, durability, and beauty. The space between the outer and inner cases is filled with mineral-wool filling, and this filling is so put in that it can not settle or shake down. The floors of the provision chambers are covered with zinc, and are on a level with the bottom of the doors, making it easy to keep clean should anything be spilled therein. The ice and provision chambers are lined with zinc of the best quality, the joints being carefully soldered to prevent anything from leaking through. Provision chambers are furnished with bright tin racks, light, clean, and open, to offer no obstruction to the circulation of air. The finishing is done in shellac and the best quality coach varnish. Locks and hinges are of bronze or finely polished brass. The water tank is white-porcelain lined, with bronze faucet, nickel plated. All refrigerators are mounted on casters, the larger size being provided with heavy two-wheeled antifriction casters. The locks on these refrigerators are of the lever-clamp system and make the closed doors air-tight. They are automatic in their operation. The sideboard refrigerators exhibited by this company were constructed on the same general plan as the household and grocers' refrigerators shown in the foregoing diagrams. They were made with the same packing and flues, but with very handsome trimmings and sideboard fittings, making them very pleasant to look at as pieces of furniture, and worthy of high commendation.

The Alaska Refrigerator Company, of Muskegon, Mich., is one of the largest manufacturers of refrigerators in the world, and disputes with the Belding Company the honor of being the largest. Its exhibit at the Columbian Exposition was very handsome, and reflected great credit on the company.

General method of construction of the Alaska refrigerators: The outer cases are made of ash, oak, or soft woods, dried in hot-air dry kilns. The panels are in one piece, grooved into the rails and stiles, which being mortised together makes a tight cabinet. All the joining and cabinetwork is good. The inner case or body is of kiln-dried, closely matched, odorless wood, lined with zinc, and fastened together with hard-wood cleats, which support the outside case, making the cases all strong and durable. At the base of the refrigerator is a solid one-piece corner block, thus doing away with the ordinary miter joint. To form the feet, the front, end, and back stiles are extended, making the feet strong. The space between the outer and inner cases is filled with a thick charcoal packing of from 1½ to 3 inches thickness, dependent on the size of the refrigerator. The door stops are thick, with overlapping joints. The floors of the provision chambers are level with the bottoms of the doors, making it easy to keep clean should anything be spilled in the provision chambers. The ice and food chambers are lined with zinc of the best quality, with well-soldered joints to prevent leakage. The storage chambers have metal shelves,

which offer no obstruction to the circulation of air. The finishing is done in shellac and fine coach varnish. The locks and hinges are of bronze, except in the cheaper grades of soft-wood refrigerators. The casters are heavy and antifriction. The diagrams will show the theory and method of construction.

The air in the provision chambers, warmed by contact with food, expands and rises, carrying with it the impurities thrown off by the food. By means of the side flues the ascending columns of air are carried to an opening over the center of the ice chamber, whence it passes over and around the ice, and chilled by its contact with the ice falls through the opening under the ice to the storage chambers below.

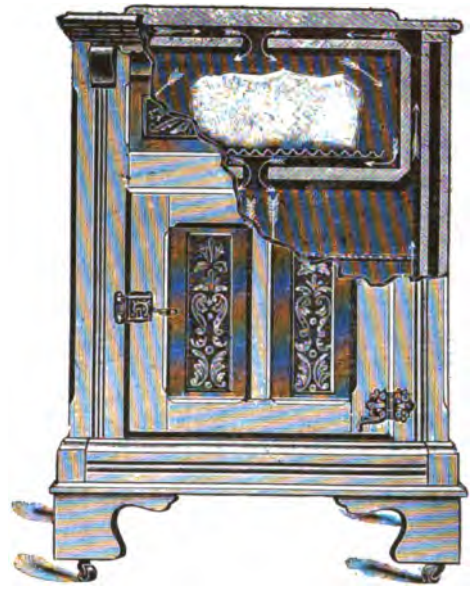


The Alaska theory. The air circulates in the direction represented by arrows.

The moisture is condensed on the underside of the ice rack and on the walls of the air flues, and the air enters the food chambers dry and pure, the ice having taken up the impurities carried up from the food chambers. These impurities are carried off with the melted ice water by means of the straight drain pipe at the rear, which terminates in a trap. This trap will be clearly understood by the illustration, and is one of the very best in use. The trouble with many of the traps is a tendency to overflow, but in this that trouble seems to be well guarded against.

The Alaska system is still further illustrated by this diagram, which shows the case partially cut away to disclose the ice and provision

chambers of one of the smaller sizes. The insulation is also shown between the outer and inner cases. The ice rests on a corrugated



Showing inner circulation by condensation.

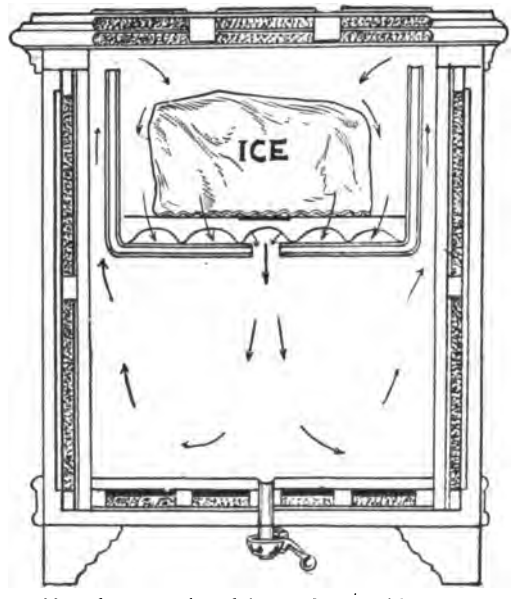
galvanized-iron rack, which is so constructed as to leave an air passage under the iron.

The illustrations below show the trap. It is placed in the provision

chamber just beneath the ice chamber, where it can be easily reached to remove when necessary to clean. The waste pipe is made straight,

by using this trap, which makes it easy to clean. By removing the ice rack a stick can be run through the pipe, which will take off all deposit that may collect. The dotted lines in cut show the end of the waste pipe entering the trap. The corrugated center cup keeps the water away from the outside shell so that no moisture will collect on the outside of the trap. The shape of the inner piece is such that the overflow will follow to the point and drop through the center of waste pipe.

The G. M. Shirk Company, of Chicago, Ill., with factory at Peru, Ind., manufactures the North Star refrigerators, which are of similar construction to the refrigerators just described. They are built of well-seasoned hard woods, dried in hot-air kilns. The panels are of one piece, grooved into the rails and stiles, which, being mortised together, makes the cabinet tight. The inner case is of kiln-dried odorless wood, closely matched, and lined with zinc. Hardwood cleats support the outside case, making the whole box strong and durable. The floors of the zinc-lined storage chambers are level with the doors, and are easily flushed for cleaning. The joints of the zinc lining in all the compartments are carefully soldered. The provision chambers are equipped with movable metal racks, and the interior can be thoroughly drained, the drain pipe and trap being well placed and arranged. The locks and hinges are of bronze, and in those having a water tank the tank is porcelain lined, with bronze faucet. The finishing is in shellac and varnish. These refrigerators are mounted on antifriction casters. The locks are of the wedge system, and make the doors air-tight. The plan of circulation and construction is shown here.



Plan of construction of the North Star refrigerators.

The ascending column of warm air, forced out of the provision chambers by the descending column of chilled air, reaches the ice chamber at the top of its sides, and passes around and under the ice to the central opening, under the ice rack, which leads to the food chambers below. The air is relieved of moisture before its return to the storage chambers, and these are always in a dry condition. The

special form of trap, it will be seen, is a cup with a weighted valve. The drainpipe discharges the melted ice water into the cup, and when the weight of water is in excess of the valve weight the valve opens and the water is discharged, and the valve automatically closes, and the entrance of outside air is stopped. This trap, like almost all the others shown at the Exposition, is instantly removable and is very simple.

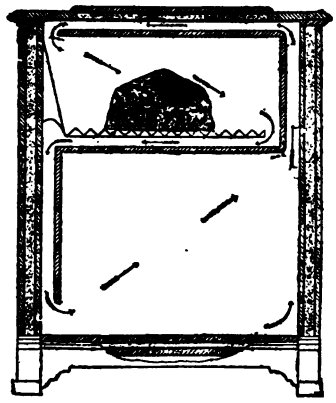
The Summit Refrigerator Manufacturing Company, of Michigan City, Ind., were well represented by excellent samples of their work, both in household and sideboard refrigerators. One special sideboard refrigerator was a beautiful example of careful cabinetwork, with hand-carved panels and fine workmanship throughout. The Summit refrigerators are constructed of kiln-dried oak or ash outside cases, and tongued and grooved poplar inside cases. The panels are of one piece and grooved into the rails and stiles, which are mortised together. Hardwood cleats hold both cases together. All the chambers are lined with zinc, with galvanized-iron shelves and ice racks. The inner wall of the outer case is lined with waxed oderless paper, which, with the air space, furnishes the insulation. The floors of the food chambers are level with the door bottoms. The casters are self-retaining and antifriction. The trap is a siphon trap attached to the ice chamber. The circulation system provides for separate flues from each food chamber to the top and sides of the ice chamber. This system differs from those heretofore described in this double-flue system for ascending air from the food rooms and in the use of the siphon trap attached to the ice chamber, other traps being placed at the outlets of the refrigerators.

The method of construction and circulation is shown fully in accompanying diagram.

The above cut shows the interior construction and double system of circulation of the air currents in the Summit refrigerator. The arrows in the cut show the direction of the air. The cold air falling

from the center opening in the ice chamber displaces the warm, impure air thrown off by the provisions. This impure air takes the only course open for it, through the side flues at the ends of ice chamber over the top, and is discharged through side flues in the lid indirectly on to the ice, and through end flues at the bottom of provision chamber, passing up directly into the ice chamber, where it is purified by passing over it. By the latter course of circulation a uniform temperature is had. It then falls into the provision chamber again in the form of pure, cold, dry air, and circulation is thus maintained.

The Hurd Refrigerator Company, of Duluth, Minn., was represented by a line of household refrigerators, which were duly entered for examination, but, in addition, this company had grocers refrigerators and sideboard combination refrigerators which were not entered for examination, having been overlooked by the company until too late. The household refrigerators are made of kiln-dried hard woods for the outer cases, and odorless poplar, tongued and grooved, for the inner cases, the latter having an inner lining of zinc. All the panels are in one piece, and the rails and stiles are mortised together. The trimmings are all of bronze, and the lock is a wedge lock, tightly fastening the door, and taking up all wear. The trap and waste pipe are good, and the interior is readily cleansed. The circulation is shown by this diagram.



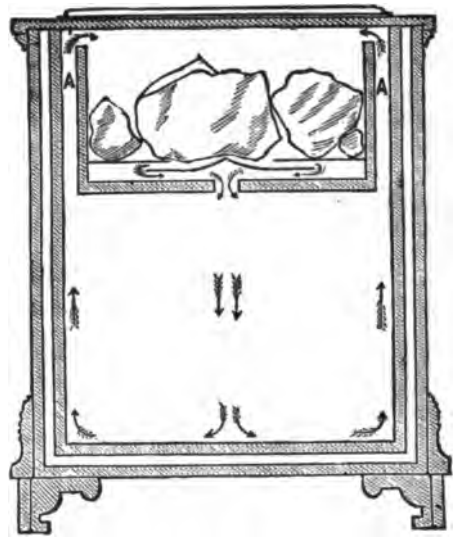
The Hurd system of circulation.

It will be seen that this is almost a radical departure from the circulation systems heretofore illustrated. There is no central opening from the ice chamber to the storage chambers below, but instead the cold air passes entirely under the ice to an opening into a side flue through which it is conducted to the bottom of the food chambers. The chilled air accumulates in the food chambers and gradually forces out the warmer air through the side flue on the side opposite to that occupied by the cold-air duct. The warm air is conducted over the ice chamber through its flue to an opening at the opposite side, where it is discharged into the ice chamber to again be cooled and passed to the provision chambers.

The insulation is provided for by packets of mineral wool.

The Grand Rapids Company make what they call the Leonard cleanable refrigerators. The outside cases are of kiln-dried oak or ash, finished in antique, with bronze trimmings. The panels are of one piece, grooved into the rails and stiles which in turn are mortised together. Between the inside and outer boxes there is a filling of

charcoal, and between the inner case and its zinc lining is a paper wall. Wool felt is made use of also in one line of these refrigerators to more perfectly secure insulation. The inner box is made of 1-inch thick poplar boards, to which are nailed upright cleats of hard wood, and to these the outer case is fastened. The flues are made removable, and the arched center false bottom in the ice chamber is of galvanized iron. The casters are heavy and of lignum-vitæ. The trap and drainpipe are arranged to rapidly carry off all waste water and at the same time prevent the entrance of warm air from the outside. The lock is arranged so as to grip the door at top and bottom as well as at the side, thus securely holding the door in place and preventing warp. The sideboards shown by this company were of the same general plan in construction but very highly finished with tasteful designs, making them attractive pieces for the dining room. In all the racks, made of corrugated iron, there is neither solder nor rivets used; the iron is bent over the ends of the bars and thus fastened. This diagram shows the method of circulation.



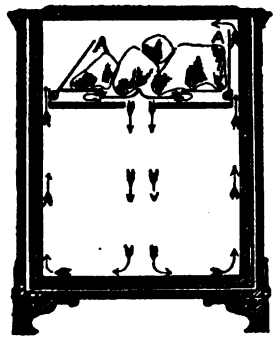
Leonard cleanable refrigerator.

The inner walls of the warm-air flues, A A, which are removable, are constructed of galvanized iron, kept cold by the ice in the box. This offers a condensing surface to the ascending warm air and partially cools the air. All vapor condensed here runs down the iron and is caught by the bottom of the ice box, which projects beyond the iron for this purpose. The air is next passed over the ice, where it is again condensed and cooled, to openings in the false bottom, as shown by the arrows; to the center, where it passes to the provision chamber pure, dry, and cold, falling to the bottom and forcing the warm air up into the ice box, to be again condensed and purified.

The Northern Refrigerator Company, of Grand Rapids, Mich., were represented by their glacier refrigerators and sideboard refrigerators. These depend for insulation upon a combination of the dead-air space and a wool-felt packing. The outer cases are made in either hard or soft woods, with one-piece panels grooved into rails and stiles, which are in turn mortised together for strength and durability. The two cases are fastened together with hard-wood cleats, and the chambers are all lined with zinc, while in the ice chamber is an arched

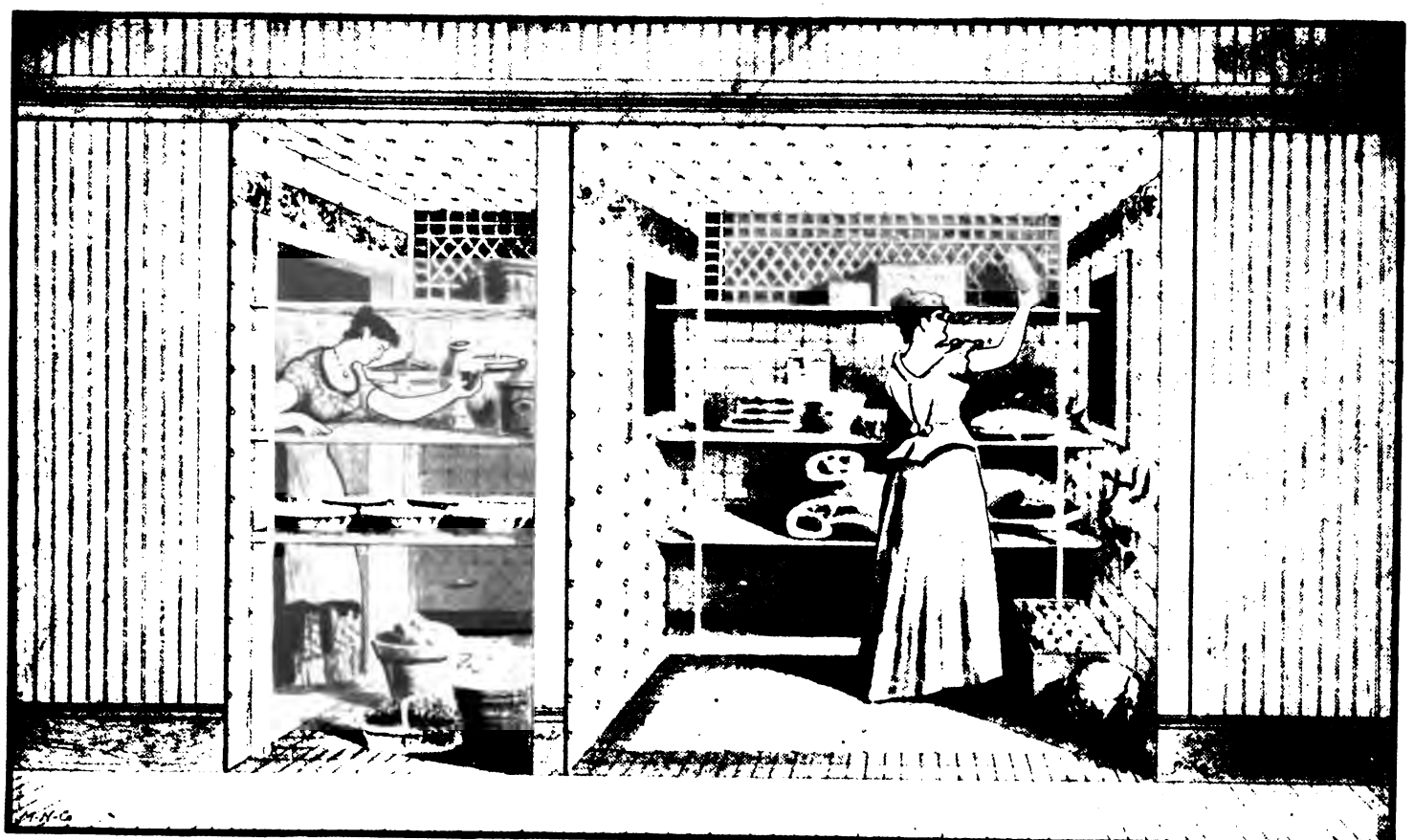
false bottom of galvanized iron, beneath which the cooled air passes to the opening leading to the food chambers below. The flues are all hinged for cleansing the refrigerator easily, and through these the ascending column of warm air is discharged into the ice chamber at the ends of that chamber. The lock has a horseshoe handle and a powerful spring latch. The casters are large. The trap is the same as is used in the Leonard. The finish is in shellac and oils. As will be seen by the diagram this is almost a duplicate of the Leonard.

The operation of the refrigerator is illustrated by the sectional view. Ice being placed on the false bottom in the upper compartment, the air under the false bottom becomes very cold and heavy and falls through the opening into the provision chamber below, forcing the warmest air up through the flues A A at the ends, where it strikes the ice and is condensed and cooled. The sideboard refrigerators were similar in appearance and construction to those exhibited by the Grand Rapids Company and possessed the same qualities of design and finish.



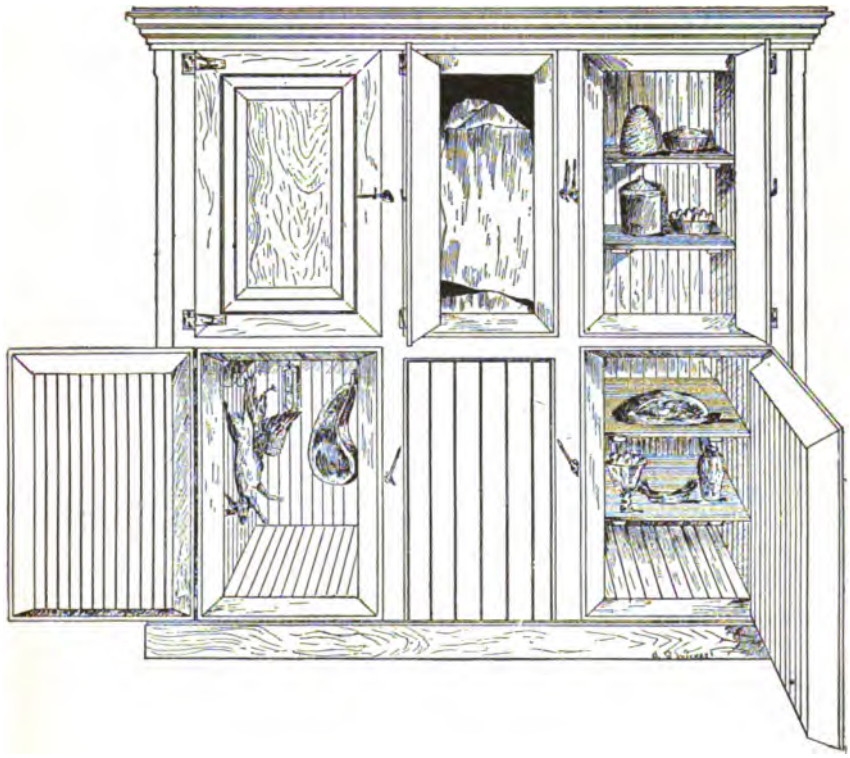
Sectional view of the upright refrigerator.

The Wickes Refrigerator Company, which has over 8,000 refrigerator cars at work on the different railway lines of this country, makes also a specialty of refrigerators and rooms for hotels and houses, as well as cold-storage plants. Their tile-lined rooms and refrigerators are intended to supply ample space for the storage of large quantities of food. The cooling of the air is secured by ice in an open-work ice crib, with projecting leaves on its outside. The ice-cold water from the melted ice is retained in the line traveled by the circulating air, and thus not only contributes to the purification of the air, but also assists in chilling it. The ice tank is composed of strips of galvanized iron, interlaced like basket work, to form a strong and durable receptacle, and permits the air to come into direct contact with the ice through the multitude of interstices. To increase the cooling surface of the ice tank, extra short strips of metal are passed through every crossing in the basket work, and the ends of these extra pieces of galvanized iron are bent outside. In this way the air current, which passes from the provision chambers through a wire gauze opening on the top of the tank front to the ice, encounters at once a very large cooling surface of metal, and being chilled falls rapidly around the ice to the free opening below, where it reaches the storage rooms. The ice is supported in the ice chamber or tank upon strong oak bars, beneath which are many feet of interlaced galvanized wire, placed there for the purpose of arresting the ice-cold drip water as it falls from the ice, so that the air as it passes around the ice to the opening



TWO-COMPARTMENT REFRIGERATOR ROOM, FINISHED INSIDE WITH MINTON TILES AND GALVANIZED-STEEL TRIMMINGS.

into the food chambers is compelled to pass through this cold water, and is thus purified. The moisture in the air is taken from it by condensation upon the metal surfaces which it strikes before it reaches the provision chambers, and thus enters these pure and dry. The novel feature exhibited by this company consisted in the tile lining for their refrigerators, which enabled them to be kept absolutely sweet and clean at all times. This company furnished for the Department of Agriculture at the Paris Exposition of 1889 a cooling room 40 feet in length, divided into three compartments, and for this refrigerator the



Small refrigerator with four compartments, standard size.

Department received a silver medal. The use of white glazed tiles in the refrigerator rooms adds a beauty and suggests perfect cleanliness. The methods of construction are shown in the accompanying two diagrams, one showing a large household refrigerator and the other a two-compartment cold room.

The Butcher's cooling rooms exhibited by Paul J. Daemicke, and Wolf, Sayer & Heller, both firms of Chicago, very much resembled each other, differing in the arrangement of the drip pans and the method of separating the main storeroom from the compartment

devoted to retail business. These cooling rooms are usually built in sections at the factories and are easily put together when they have reached their destination. They consist essentially of an upper ice chamber and two compartments, or more, below and in front devoted to storage of supplies. As these cooling rooms must contain large quantities of ice, the ice chambers are made very strong, and the stout racks and fenders are capable of holding up several tons of ice if necessary. Under the center of the ice chamber and extending its entire length, runs a watershed from which the waste water of the melted ice runs into inclined drip pans, which, by a system of levers, may be raised or lowered as deemed advisable, and by the closing of the spaces between the drip pans and the edges of the watershed the circulation is regulated at will. In the Daemicke cooling room these drip pans are two in number, hinged at the sides nearest the walls, and with protecting curtains at the other sides, where by a screw and system of shafts they are raised or lowered to close or open the air passage. In the Wolf, Sayer & Heller cooling room the drip pans are six or more in number, which by an arrangement of levers work together and are opened or closed to regulate the circulation. These drip pans are hinged and adjustable at their vibrating edges toward and from the overhanging edges of the watershed, which by its overhang prevents any drip of water into the storage rooms below. In the Daemicke room the exhibit chamber is separated from the cooling chamber by a plate which constitutes a support for a meat rack on which the joints of meat are suspended for exhibition. It is provided with glass windows through which light is admitted into the cooling room. In both these cooling rooms the supplemental show chamber is a very important feature. It is so constructed as to slide the contents forward at will. The sliding compartment is intended to close the chamber by means of a hinged panel whenever it becomes necessary to take from it the supplies to accommodate a customer. As the bottom of the small compartment is moved forward, the panel, hinged at the top and front, falls into place and prevents the entrance of outside air and thus maintains the temperature. The workmanship of these refrigerators is excellent, and the finish makes them attractive and well adapted for the special uses for which they are designed. The air is kept pure and dry, and the walls of the cooling rooms exhibited not the slightest trace of moisture, nothing showing more completely the perfect circulation. Both of these firms also exhibited in connection with their cooling rooms a complete line of supplies for butchers.

SODA-WATER APPARATUS.

America is the home of the soda-water fountain, and the many beautiful designs displayed at the Exposition proved that the business of dispensing soda water to a thirsty public must be conducted in a man-

ner to assure the public that the apparatus receives constant inspection and is kept in a condition of perfect cleanliness. When the business was first started many years ago by John Matthews, the apparatus used was as plain as it was possible to make it, but the exhibits shown at the Exposition were all marked by elaborate display of silver-plated ware, beveled glass, onyx and marble columns, and a general endeavor to show that it is possible to make even soda-water fountains beautiful. The dispensing apparatus shown by Matthews, Tufts, Lippencott, Puffer, and Zwietusch were all constructed on substantially the same general plan. The soda water, forced from the iron fountains by a strong pressure of gas, is passed through piping in the ice chamber, where it is cooled, and then drawn through the draft tube into the glass. Through block tin to the water in the pipe, or in a special form of cooling chamber, there is communicated an intense degree of

Generator and fountain of 1832, invented by Paul C. Lanning. The first machine for generating gas under pressure for charging portable fountains.

cold, but the water is in all cases kept pure until it enters the glass, where it is flavored with sirup. The sirup cans are constructed either to serve their contents from a vent in the bottom, or are inclined, or will tilt. They are always removable for cleaning. With all of these manufacturers marble and onyx are the usual and favorite material wherever it can be used, and all their designs were in marble and onyx. In all the marble is sawed extra thick, carefully cut, and accurately fitted. The cases are joined with silvered bolts and bronze clamps, to insure stability. The ice box is made of heavy copper, tinned on both sides. The coolers, or cooling pipes, are so placed that the ice produces its greatest effect. Between the ice box and the outer wooden case is a dead-air space, and insulation material to prevent sweating. The draft tubes are elegant in design, simple in construction, and durable. The whole apparatus is simply and yet substan-

tially made, and is in marked contrast to the original charging apparatus figured below, which served to introduce the now fashionable spa to the public.

The dispensing apparatus which accompanied the generator of 1832 was a very plain box of wood with a single draft tube, and was not very attractive in appearance. Here is a dispensing fountain of 1893 which shows the advancement. It is a double wall apparatus, and has the front of the bodies of Genoa green marble, with bands of Gryotte, the lids and base of black, the ends of Tennessee of superior quality, extra thick, and overlaid with Gryotte. The draft tubes, which are of a novel pattern, are set on tablets of onyx. Mirrors placed at right angles to each other connect the bodies; and in the three-cornered niche thus formed stands an exceedingly pretty tumbler washer, which the mirrors reflect fourfold. Three French plate-glass mirrors with beveled edges, engraved borders, and frames of Italian Bardillo marble, engraved and gilded, constitute the background of the beautiful upper fabric. Columns with shafts of opalescent Mexican onyx, capitals and bases of black, grand antique, and Gryotte, sustain a canopy composed of Gryotte, Belgian black, grand antique, Tennessee, and Italian Bardillo. The cornice is unique in design, exquisitely engraved, and adorned with jewels and small beveled mirrors. Suspended from the cornice are lanterns of silver and crystal. Dimensions: Extreme length, 11 feet 4 inches; width, 2 feet 2 inches; height, 8 feet 6 inches.

The general interior construction of all dispensing apparatus is similar, and while all have minor variations in draft tubes and cooler, or fruit-sirup cans, they are built on one general plan which permits these minor variations. But when the exterior construction is viewed they differ widely, as each manufacturer follows his own taste. It is for this reason that while the Low art tile soda fountain has an interior construction substantially like that of all the others, it is yet radically different so far as the exterior is concerned. All other manufacturers use marble and onyx for decorative effect, but the Low art tile fountain use art tile. While other fountains are trimmed and decorated, each one of the Low art tile fountains is truly a work of art. While many of the fountains heretofore made have been very ornate and expensive they have not always possessed true artistic merit. The difficulty has been that marble is not readily susceptible to the hand of the designer, and the production of symmetrical forms or pleasing ornamentation is costly. With tile this difficulty is overcome. The clay in the hands of the potter assumes the shapes his mind desires, and symmetrical lines and pleasing forms of ornament appear responsive to his touch. The variety of form which the clay can be made to assume is infinite, and the truly artistic results which it gives makes the tile a very satisfactory exterior for soda fountains. Not only is artistic form at command in the tile, but to beauty of form is added beauty of color and finish.

SODA-DISPENSING APPARATUS OF 1893.

The art tiles of this country are largely due to the skill, energy, and indomitable perseverance of one man. His experiments continued for months; his many failures, the long delays before experience taught better methods, all were to him but as difficulties to overcome before success could be reached, and so regarding the various hindrances which beset the early manufacture of art tiles in this country, Mr. Low pressed forward until his tiles have now taken the highest rank in the world, and are used in all kinds of work where decorative effect is desirable. It is especially in what is called relief work that the Low art tiles are most beautiful and best adapted to the special decoration of soda fountains. By the Low process the color values of the relief tiles are enhanced; the colors are made to glow and deepen over the surface until the tile and its color express the design in the most perfect way. The glazes used are not the result of chance, but are carefully studied out, and are so applied as to modify the design. Melting in the intense heat of the kiln they flow freely over the surface of the tile, filling up depressions, and thus forming the deep shadows, and leaving the high points of the relief design with a thin covering of the glaze, and so expressing by the depth and intensity of the glaze, as well as the figures in relief, the beauties of the design. In the tiles of the fountain exhibited at the Columbian Exposition the most charming effects were produced by these combinations of figures in relief, colors, and glaze. The sky was as perfect as if laid on by the brush of the artist, while the figures in the foreground at the spring were brought out in strong relief, yet with a softness impossible by any other process. This fountain was made for the Exposition as an illustration of what could be done with the art tile, and certainly this fountain was the finest and most artistic fountain displayed. This special design was, however, not the only one turned out by the Low Art Tile Company, but from its peculiar beauty of design and perfection of finish deserves special mention apart from the other products of the company. What more appropriate design for a soda-water fountain than a Grecian spring, to whose health-giving waters are gathering the birds of the air and the beasts of the field as well as the children of men? Another design for decoration of a fountain has for its central panel the figure of a tired and thirsty youth eagerly drinking from a cup, while for another the main arch is a single panel representing the gathering of the grape by the laughing cupids. But how shall the life and color of the scene be fitly described or the effectiveness of the tile as a fountain decoration be shown. Certain it is that tile is more effective than marble or any similar material for a fountain decoration, and as it is not susceptible to the acids, which eat away and discolor marble, it ought to be more durable. This is not the place to enter into a history of the tile as applied to other purposes than soda fountains, but it is enough to say that we are begin-

ning to appreciate the usefulness and decorative value of the tile in all places where tiles can be used, and among the tiles suitable for general decoration the very best made in the United States are the Low art tiles, which are truly works of art.

The Ironclad Manufacturing Company, of New York, and Otto Zwietusch, of Milwaukee, Wis., exhibited steel fountains. The former were strongly banded, and put together by rivets and the sweating process. They were lined throughout with solid block tin, and the bottoms were supported and strengthened by an arched bridge. This steel fountain claimed to have so strengthened the weakest part of the fountain that it will be able to stand greater pressure than heretofore. The Zweitusch steel fountains are constructed of two pieces, and hence are equally strong at all points. They are lined with solid block tin throughout, and are very carefully put together. These fountains are of drawn steel, and the entire fountain, except the bottom, is in one piece, so doing away with the necessity of bands and rivets. The bottom is trussed, and the two parts are strongly put together, sweated and riveted. These steel fountains are made to withstand very high pressures, and are probably the strongest fountains made.

The Ironclad Company also exhibited a very fine line of all kinds of enameled ware, milk cans, etc. These all displayed careful construction.

SEWING, CROCHETING, KNITTING, AND EMBROIDERY.

BY

Miss HELENE E. CORRELL.

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SEWING, CROCHETING, KNITTING, AND EMBROIDERY.

By Miss Helen E. Correll, *Juror*.

INTRODUCTION.

These classes are so intimately connected in kind that it seems almost impossible to treat them separately. Both include sewing, crocheting, knitting, and embroidery. One class may be considered as a treatment of these handicrafts in their elementary forms, while the other may be looked at from a more advanced position with reference to their artistic relations. The line between them, however, is hardly distinguishable and I choose not to define it in terms, but rather to treat both classes as a unit, differing only in its stages of development.

HISTORY.

The origin of these industries is so ancient as to be lost in the labyrinth of the ages, but it is commonly held that they were born in the realms of the gods and that swift-winged Minerva taught the nymphs so deftly and skillfully as to enable them not only to imitate each mystic stitch, but also to excel her in production. This myth may also be reason for the fact that this handicraft is a woman's work, it being an undisputed truth that this art is the only field where a woman's right to independent act and thought has never been disputed. Leaving the vague and doubtful realm of myth, let us come within the boundaries of historic truth and look at the development of these crafts from a surer, a more authoritative position.

The Chinese, the East Indians, and the Egyptians, in the order named, were the first to bring these arts within the range of system, their scope and ornament, however, being limited to rectilinear figures. Following this rude beginning, the Assyrians introduced an ornamentation based upon the simpler animal and human forms, yet always without perspective. A naive conception truly!

This, however, was the parentage from which sprang the Greek and, later, the Roman crafts. These were softer and smoother creations, it is true, but hardly more realistic than the Assyrian. The Roman system came in time to be known as the Phrygian work. Its characteristic was a great elaborateness of colors, gold and purple predominating. Its use was limited, however, to the borders of dresses, draperies, and the like. The Romans went conquering over Europe, Asia, and

Africa, carrying with them not only their laws and language, but also their accomplishments, and thus became the schoolmasters of all these regions. But Rome was interrupted in its effort for universal power by its own unruliness, extravagance, and Christianity. Yes, Christianity—a slight flame, easily extinguishable as it seemed—gained strength with every effort to quench it, but at last burst forth in majestic light, overshadowing and overwhelming with its glare of truth the outlived faith of the Romans. New ideas of beauty, new ideas of art were set up and became dominant as the strife for existence ceased and the creed assumed the broad basis of a state religión. The secret worshipping places of the followers of Christ, the dark vaults of the catacombs, and the open air, with the starry sky above them, were abandoned and replaced by basilicas and domes, indicating with their mighty arches both the vaults and lofty heavens so lately abandoned.

The greatest simplicity was everywhere observed. The times were still too grim for sweet art to develop. The decorations of the churches were of the most primitive kind, and the vestments of the bishops plain, if not poor. Time brought changes, however. The sunshine of peace and power awakened the love for the really beautiful. Franz von Assisi, St. Franciscus, with his admiration for nature and its beauty, so impressed himself upon the age as to become a forerunner of better things—a foreboder of the springtime of art. The walls of the churches were covered with pictures, the altars with embroidered cloths, and the vestments of the bishops and priests with embroidered scenes of the life of Christ and his apostles. In the days of the minstrelsy, however, a new figure was added, the figure of the Holy Virgin, which soon became the most important of all.

Art embroidery developed first in England. The attainment of its highest power was reserved, however, for Burgundy, the Burgundian robes being in our day the marvel of the beholder. It had been said, by writers in other lines, that the true type of the beautiful woman is Burgundian. If this be true, it suggests the question: Is not the highest form of art embroidery very closely connected with the best types of female beauty? To say the least, it is a singular coincidence that the rarest types of this should only be found in the region where flourished the choicest patterns of that.

In the eleventh century the Moorish literature and art began its course of power. France, Germany, and Burgundy were soon influenced by the double array of the Moorish-Spanish technics and gorgeous Moorish colors. These were the more readily adopted after the Crusades brought the knights and clergy of Europe into contact with the taste and art of the Orient.

The art embroidery had long ceased to be strictly clerical, the skilled hands of the nuns and their pupils not seldom being employed with

ornaments for emperors and kings, dukes and knights. The fair pupils of the nuns, when they returned to their castles and homes, carried with them the skill, the taste, and love for art they had embodied during their school time; their hours of leisure at home were spent in embroidering and reproducing scenes of daily life, scenes of battles, and the sweet figures of the Holy Virgin.

Life began to center in great cities and great wealth began to be accumulated; with these came a love for art in house and home, from which in due time came our splendid art industries, the greatest product of the ages. The names of Peter Iamnitzer, Peter Vischer, Hans Holbein soon awakened an echo of enthusiasm at their mention and aroused a general love for art among the whole people.

The Romanic, the Byzantian, and Arabian, hence Moorish gave place in Germany to the Gothic style, and this, not in architecture only, but also in painting and embroidery. The broad well-set arches of the Romanic gave place to the loftier and more graceful ogivals; the stoutly built figures of the saints and angels grew little by little in length and took more graceful positions. By this time churches and houses were alike adorned with exquisite embroideries and laces. Each table was covered with handsomely worked spreads and the walls draped with costly carpet, the handiwork of women of artistic tastes and perfect skill. The vestments of the clergy were costly and altogether products of the highest art, the technics in every way equaling the harmony of the color and the realistic demands of the times.

There is a summit to everything, however, and that summit was reached by the art handicraft at the middle of the fifteenth century—High Gothic marked its decline. The Renaissance began to run its way, though only for a short triumphant period. The fierce and icy storm of the Thirty Years' War soon nipped its flowers of beauty, and strewed them in ruin o'er all the land. The wealth, the art, and the people of Germany were alike smitten by its destroying hand. From this blow the country never recovered until this century. In France the Rococo and the Barok continued to flourish, while in Germany the struggle was for bread to feed its people. And if some giddy princes tried to imitate their lucky neighbor, it was accomplished only by oppressing their subjects, retarding not only the normal development of art, but the country as well.

Since 1848 there have been better days in Germany. The people have gained confidence in the fatherland and have set up in their hearts the old time love for art. A new era began. Louis I, King of Bavaria, and an artist at heart, did very much to bring art and art industry to life, and it may be easily proved that Munich was the starting point to this great resumption. Museums were founded in which the finest specimens available in wood carving, silver embossing, laces, and art embroidery were installed. Academies and schools for

art handicraft were also established and supplied with orders for the decorations of the royal castles, thus making the prosecution of art study not only possible for artists, but profitable as well.

The old technics and styles soon received and are now reaching perfection in the homes of the people. With the opening of this century new conditions of production were established; machinery was perfected and introduced. In addition to this, the development of the science of chemistry enabled art industry to enliven its work with greater variety of tints and colors.

THE ACTUAL EXHIBIT OF GERMAN ART INDUSTRY AT THE WORLD'S COLUMBIAN EXPOSITION, CHICAGO.

First of all is the systematic display of the girls' public school at Breslau. This comprises knitting in its simplest form, crocheting, plain sewing, piecing, darning, marking, and simple embroidery. The pupils begin at 7 years of age, and go on with the elementary study of needlework until they are 14. The exhibit is remarkably accurate, considering the age of the little workers, and the system of the school is highly commendable and has gained an award. A further proof of excellence is furnished in the fact that the system has been adopted in almost all of the public girls' schools of Germany.

The Lette-Verein, at Berlin, the first industrial school for women in Germany, has made a large display of needlework, beginning with plain knitting, crocheting, tatting, and sewing. This includes masterpieces of art embroidery, drawnwork, lace making, both needle and bobbin. Special mention should be made of a bed cover in white-silk embroidery and a handsome tablecloth in needle painting and raised gold embroidery. This school was founded in 1866, and has been honored with prizes wherever it has exhibited, and at this the greatest of all expositions it has earned not less than three awards.

Of younger date, but on the same principles as the latter school, is the Woman's Educational Association of Breslau. The aim of this school is to give women a profession in which needlework shall form the most prominent part. This school sent many different handsome pieces, among which a Bible with an elaborately embroidered cover and a scarf in drawn work deserve special notice.

The schools of Reyet and Reutlingen are purely art needle schools, educating their pupils to become real artists.

Reutlingen has sent many exquisite specimens, exemplifying all the different technics of art needlework. One may see the cross-stitch, the haute-lisse, the Arabian, Russian, and old German style and technic, as well as Venetian lace, the ancient macramé work, the plain crochet, the bobbin lace, and the woolen framework. Because of the most excellent work of this school it is most favorably known over all Europe, and its pupils are in great demand as teachers of needlework;

in fact, they hold the leading positions in the schools of the world. This school also gained an award.

The school of Reyet sent a portière in modern style, combining gold and silk embroidery, a table cover in Venetian gold lace, and a pillow sham in white embroidery. All these exhibits are artistic and of quite a superior workmanship.

Besides these school exhibits I have to mention the artistic appliqué work and gold embroideries by Mrs. von Wedell, comprising two cushions, two altar cloths, and a large banner.

Mrs. Jacobs, of Inverbrucken, sent different linen embroideries in the old German style. Mrs. Gerson exhibited smaller articles in macramé, reticella, Italian cross-stitch, silk embroideries, and the French ribbon work.

The most striking were the exhibits executed by Miss Barbara Wolff and Miss Yörres, of Munich. I mention also the portière of Miss Wolff, on white satin, in Renaissance style. The design is perfect, the colors gorgeous, and the execution perfect in every particular. A small table cover in appliqué is also a masterpiece of taste and skill.

The crown, however, of all the exhibits in the German section of the woman's building is a wall hanging 7½ yards long by 5 yards wide. The above-named well-known artists, the Misses Wolff and Yörres, united their efforts upon this herculean task, Miss Wolff furnishing the design and colors, while Miss Yörres executed the work. The hanging represents a hunting party received by Louis XI of France. Horses, hounds, and people crowd in on a meadow spread with flowers, in the center of which the King has taken his stand, shaking hands with and bowing graciously to a fair lady who is being presented to her lord and king. A page holds the bridle of her ambler in the distance, and the whole picture presents all the beauty of the art of the Middle Ages. The execution of the work required several years.

Besides this work Miss Wolff exhibited a large number of colored designs for vestments, some of which are handsomely executed. The technic chosen for the vestment is the haute-lisse stitch, in which Miss Yörres excels. She was the artist who was selected to adorn the state room of the Castle Herrenchiemsee. The embroidered taborets and chairs prepared by her are the delight of artists today, as they were the delight of the then artist king, Louis II of Bavaria. Of the four chairs but one of the originals is here, and of the twenty-four taborets but two have been lent to this Exposition by the Kingdom of Bavaria.

The haute-lisse pictures, so delicately worked on the chairs and stools, are surrounded by raised gold embroidery. The figures, nymphs, and amorets are exquisite in design and color, while the technic vies with the most perfect French.

Another important exhibit of art embroidery was sent by the National Museum of Munich. It consists of wall hangings in gold relief embroidery on blue velvet. The work was executed by Alkens. The style of the room is rococo, and the furnishings are of the same style. Adjoining this room are two apartments furnished, the one in German, the other in Italian Renaissance. The cushions, wall panels, coffers, chairs, table covers, and scarfs were all designed and executed by Mrs. Schiffman, directress of the School of Decorative Art in Munich. Her work is altogether different from that of Miss Yörres, yet quite as artistic and magnificent. Mrs. Schiffman delights in the Renaissance, of which she is an artist of the first rank. Her exhibits are so perfect in style and so splendid in technical art as to puzzle shrewd connoisseurs of the Renaissance period as to their date. The classes of this lady are well attended by gentlewomen who carry their love of art into their homes. In addition to this she employs a large body of professional working women. Mrs. Dernburg, of Berlin, probably the most talented pupil of Mrs. Schiffman, has also established classes for the study of decorative art at Berlin, and the splendid ornaments, table covers, curtains, portières, cushions, and scarfs exhibited in the German State building are the work of this lady and her pupils. She, too, has adopted the Renaissance appliqué work. Besides this she has furnished a room in the manufactures building.

The early Gothic style is shown to great advantage by the exhibit of Mrs. Prachtel in two furnished rooms. Cushions, wall hangings, portières, and draperies abound in them, and do honor to her artistic talent.

Munich and Saxony have a very large industry in linen embroidery, in which the old German and the rococo predominate. Table linen is once more covered with figures and patterns in cross-stitch or long stitch. Ad. Deisz, Marianne, Rieppels, A. Sutman, Louise Kropf, Mina Lossow, Crescencia Petry, Olga Putz, all of Munich, are well known manufacturers of the genre of hand embroideries.

The manufacturers of Saxony excel in embroidered trimmings and dresses, as well as in curtains. They give employment to thousands of people, the principal part of which are women.

Miss Ripberger, of Dresden, inclines to the Kensington style, and produces a line of art needle work that is especially pleasing to American tastes. She displays her art in a most attractive form in a series of portières.

The Karlsruhe Art Needle School, under the patronage of the Grand Duchess of Baden, is a center of the highest art. Its pupils have the opportunity to study all styles in their purest form. The exhibit of this school is exhaustive and masterful.

In all times church embroidery has distinguished itself by costliness of material and artistic workmanship. This industry has become a

specialty in the great art of embroidery, requiring the highest styles of design and the best workmen. Everything not in conformance to church traditions must be excluded, necessitating, therefore, a knowledge of ecclesiastics, as well as of art, in its preparation. On account of these conditions, only the very best artists venture upon the perilous undertaking of church embroidery, and the art itself takes a correspondingly very high rank.

Quite a number of church embroideries are presented by Germany, some of which deserve a special notice. The exhibit of Mr. Kirsch, of Freiburg, is made up of quite a large number of exquisitely worked vestments. They do not compare in beauty of design, graceful ideas, harmony of color, and excellence of workmanship with the church embroideries sent by the Sisters Orsiander of Ravensburg, Wurttemberg.

In stating the superiority of this exhibit, I can do no better than to quote the very language which will appear upon the diploma granted to this firm, as written by the Judge Josiah H. Shinn: "I report that this exhibit should have an award for its very great excellence of design, material, workmanship, and coloring. The hand-made vestments of early Gothic designs are remarkable for harmony and variety of color, costly, elegant, and fine material, deft workmanship, power, and beauty. The designs in late Gothic are still more powerful and beautiful, and warrant in full the departure from the older and more classic forms. The designs of Professor Spiess are masterpieces of power and elegance, and lend the charm of art to the skilled workmanship of the manufacturer. The firm deserves the highest recognition from all lovers of ecclesiastical art and the highest testimonial that can be given by the World's Columbian Exposition. Its exhibit is peerless."

I close my report with the pleasing reflection that the art of Germany is thriving, a sure sign of the peaceful development of the country.

SEWING MACHINES.

BY

JAMES BOLTON.

1403

SEWING MACHINES.

By James Bolton.

The exhibits of sewing machines displayed in class 659, group 104, mark an era in the history of sewing machines manufactured for domestic or family purposes. The advance since the Centenial Exposition of 1876 in Philadelphia, though marked, is not so distinct, relatively, as is shown in machines used in the manufacturing industries.

The history of the sewing machine is a record of rapid advancement in mechanical movements and combinations of devices, which apparently had never even been thought of until the close of the eighteenth century. The first glimmer in the direction of practical mechanical sewing is found in the English patent to Thomas Saint in 1790, but it was not until 1830 that any hint of the road to practicability was found; then a Frenchman, named B. Thimonier, secured a patent, and in 1841 was able to make a number of machines of wood. These were improved upon by his later patent in 1848. Although Thimonier never reached such practical results as to bring him success, his ambition having been thwarted by the intervention of the mob, his invention had in it possibilities of which he never dreamed.

Among notable models of sewing machines from the United States Patent Office, exhibited at the Exposition, are the following:

J. J. Greenough received the first patent for a sewing machine granted in the United States. It bore date February 21, 1842. His model bears no resemblance to the machines of the present day. The needle was pointed at both ends, with the eye in the middle; the thread used could be no longer than that used in hand sewing, and the needle was pulled through the fabric, which was held in a clamp by means of nippers or pincers mechanically operated.

In March, 1843, a patent was issued to Benjamin W. Bean. He used the common hand needle, and the thread in this machine also had to be of short lengths, as in hand sewing, so that the stitch could be tightened after drawing it through the fabric full length. The material to be sewed was crimped and presented to the needle point in folds; the needle was stationary, and the fabric to be sewed was moved by means of a device of feeding gear wheels.

These early attempts in imitation of hand work were conspicuous failures, as they were based on mechanical principles which could not

be developed for sewing purposes. They live in sewing-machine history rather as pointers toward what is now a well explored field, than for any actual service in exploring it.

Elias Howe's patent was issued in September, 1846. The chief features of his machine consisted of a needle with its eye at the point to be operated vertically in combination with a shuttle. Although the eye-pointed needle was patented by Newton and Archbold in the United Kingdom in 1841, and was used for glove stitching, making the chain stitch, Howe's machine was the first to sew with a needle having the eye in the point, and which carried a continuous thread and made a lock stitch. The feed tensions and take-up devices were incorporated in his model under his patent, but were in a chrysalis state and impractical. The general principles involved, however, clearly indicated the fact that Howe's ideas were in the right direction, as subsequent history has demonstrated.

It is interesting to note in this connection that Howe undertook to improve his fortunes by going to England, and while there sold his invention for that country to William Thomas, a corset manufacturer located in Cheapside, London. Mr. Thomas secured the English patent in his own name in the year 1846, and employed Mr. Howe at regular wages to develop it for him. Although Howe received £250 from Mr. Thomas for his patent, his career in London was so barren of financial success as to cause him to pawn his United States patent, and to return to America, in a practically penniless condition, in the year 1849.

In September of that year a patent was issued to J. Bachelder, in which the chain stitch was involved. It also embraced a so-called "perpetual feed," which moved the fabric in one direction.

Barthelemy Thimonier, of France, whose invention has been heretofore referred to, applied for a patent in the United States and received the same September 30, 1850.

November 12, 1850, a patent was issued to A. B. Wilson, which included a work-feeding device roughened on the surface, which carried the material forward without penetrating it. This was considered a distinct gain in the line of practical requirements.

Grover & Baker received a patent February 11, 1851, for a machine which formed the double-loop stitch. Thread tension devices are shown in this model, and feed-actuating devices for securing the intermittent movement of the work.

Isaac Merritt Singer received his patent August 12, 1851, for his original machine. In this model he used a wheel serrulated on the periphery and operated automatically in one direction for moving the material being sewed. It also contained the yielding presser foot which completed the triumph over obstacles hitherto in the way of thorough success.

On June 15, 1852, A. B. Wilson secured a patent on the rotating-hook principle embodied in the Wheeler & Wilson machine. This machine also contained the feed-device principle familiar to-day.

W. H. Johnson secured a patent March 7, 1854, for a chain-stitch machine, which contained the principle first put into practice of feeding the goods by the upward and forward motion of the needle known as the needle or vertical feed.

The foundation patent of the Wilcox & Gibbs machine was issued June 2, 1857. That machine was developed to cover the field of chain-stitch work so fully as to maintain a practical monopoly of that special line of business until the expiration of its principal patents.

Thousands of patents in minor mechanism involved in the sewing machine and attachments for the same have been issued, and even now a week seldom passes by without an issue of a number of patents in this domain from the United States Patent Office as well as from those of foreign countries.

Among foreign inventors the name of Charles F. Weisenthal occurs in connection with the double-pointed needle with the eye in the center, said to have been patented in England in 1755, and the ideas therein advanced adopted later in the embroidering machines produced by Heilman.

The machine of Thomas Saint, before referred to, produced in 1790, was said to be intended principally for leather work. It was fitted with an awl, which was operated vertically and pierced a hole in the leather for the thread. The thread was mechanically lain across the hole, and a forked needle pressed it through. The loop was caught by a reciprocating hook. His ideas were exactly in line with the chain-stitch mechanism developed seventy years later, and it is doubtless true that he would have forestalled many of the inventors of this century if the idea of an eye-pointed needle had occurred to him.

The archives of the United States Patent Office disclose the fact that Walter Hunt, of New York, had invented a machine with a needle having its eye at the point, and had sold the same to a blacksmith named Arrowsmith, who had done considerable toward perfecting it. This was in the years 1832–1834. No patent was applied for, however, until 1853, when considerable attention had been attracted to the new industry; but a patent was refused on the ground of abandonment.

After Howe's return from London in financial straits, it was not long until he discovered an increasing interest in mechanical sewing, and that his initial efforts in that line had been so far advanced by others as to attract more than ordinary attention. He also found that the newcomers in the field were using some of the mechanical principles covered by his patents. This gave him new energy and new hope, and it was not long until he devised means to get his pawned patents back from London.

Then the legal conflicts began between the original inventors. Isaac Merritt Singer is recorded as being "the most prominent of the manufacturers if not of inventors, and an energetic pusher of the infant industry, and he became a very stubborn fighter of Howe's claims."

Howe's great advantage lay in the eye-pointed needle in combination with the shuttle; but Wheeler & Wilson had the rough-surfaced feed, Grover & Baker had the actuating devices for moving the feed, and Singer had the yielding presser foot which held the work in place, and uneven surfaces or seams did not obstruct its free movement. This group controlled the essential basic principles of the sewing machine, and these principles are all found in the lock-stitch machines of the present time.

Elias Howe having the original patent was able to force the others to pay tribute or royalties to him, but in the contract which bound them to him he surrendered his right to manufacture sewing machines, and thus it came about that the Howe machine, so called, was the product of A. B. Howe (brother of Elias), and not the production of the original inventor.

Wheeler & Wilson and Grover & Baker and Singer (who was accounted a stubborn fighter) were all mixed up in legal conflicts concerning their various patents, and were all, as well as Howe, greatly harassed by the expensive processes of the courts. Their weak condition financially was a prime factor in inducing them to adopt a course which proved to be a wise one and inured to the benefit of all: A combination was formed by which each firm manufactured machines independently, paying a royalty to Howe, and they in turn levied a royalty on all newcomers which afterwards entered the field. This coalition existed between the original manufacturers until the expiration of the original basic patents.

There has been for many years among inventors and manufacturers considerable discussion as to whether the best results could be obtained from the vibratory, rotatory, or oscillating shuttle movement.

Each, in his class, has been stimulated to profound thought on the subject, no less by his theoretical bias in favor of his particular methods than by a desire to become preeminent in his profession or craft. An additional incentive has been the piratical genius (?) both at home and abroad, whose imitations and copies of good devices have annoyed legitimate manufacturers to such an extent as to make them eager to surround themselves with advanced improvements well protected by patents.

While speed and wear, resisting qualities in sewing machines, are considered the desiderata for the manufacturer whose machines are run at a high rate of speed by steam power, ease of running and simplicity of construction are demanded in the household, and this latter fact is largely responsible for the high place which the vibratory

shuttle machine occupies in the esteem of those users of machines who do the work of the home, whereas in the factory the contest for pre-eminence lies between the oscillating shuttle and the rotary shuttle devices, both of which are susceptible of extraordinary rates of speed.

In the "family" machine no conspicuous departure from the old devices has been made beyond perfecting the bearings, improving the tension and stitch regulator devices, shortening the needle, winding the bobbin thread, and perfecting and improving the shuttle.

The range of work in the family has not been so broad as to call out inventive genius in a degree at all comparable to that demanded in the realm of manufacturing industries, hence the lesser degree of progress; or perhaps it might be said with a good measure of truth that up to the time of the Exposition in Philadelphia in 1876 the field had not been nearly so well covered with sewing machines adapted for manufacturing specialties; hence a greater degree of advance was possible in that direction.

Users of machines in the home, as a rule, adhere pertinaciously to the simple vibratory shuttle because the world is well educated in the use of that device and it requires less skill to acquire a knowledge of how to operate it.

For domestic work it has been well settled that, first of all, a machine must be so constructed as to be easily managed, and, secondly, that it must be so harmoniously adjusted as to oppose the least resistance to the operator. In both of these points the machines of to-day are so much in advance of the exhibits of 1876 that one is justified in saying that the Exposition of 1892-93 marks an epoch in the "family" machine industry, and that the mechanical achievements in this department are nearing the acme of perfection.

It is a noticeable fact that while all sewing machines for family purposes which make the lock stitch were without a positive take-up in 1876, they all show that improvement now.

The slack thread, which is occasioned by the passage of the shuttle through the loop, must be taken care of in order to produce an even and perfect stitch, and the best that had been accomplished up to the time of the Centennial Exposition was a take-up dependent upon the working of a spring in conjunction with the movement of the needle bar. Although this gave reasonable satisfaction at the low rate of speed obtained by foot power, it had in it elements of uncertainty which have been entirely removed by the positive take-up, which is as inerrant in its movements as the needle bar itself.

The needle bar which controls the action of the needle vertically; the shuttle driver which controls the action of the shuttle horizontally; the take-up which draws the slack thread at the proper moment and holds it taut; the feed dog which describes four motions in moving forward, then down, then backward, and then up, are harnessed

together with mechanism whose particularity is not surpassed by the nicety involved in the movements of the finest watch or clock.

There has been no departure in principle in these movements from those exhibited in 1876, but the method of actuation in each case has been advanced to a plane which secures the absolute certainty of positive mechanism, and there can be no failure unless it be in construction or material.

In 1876 the cogwheel was extensively used in vibratory shuttle machines. Their office was to transmit or communicate motion from principal shafts or axles to the subsidiary mechanism which involved the harmonious movements of the needle, the feed, the shuttle, and the take-up. Besides being clumsy, noisy, and friction producers, the essential point of "timing" the machine was more difficult to compass, and more liable to torment the operator who was beyond the reach of the skilled adjuster. In the exhibits of 1893 the cogwheel had almost entirely disappeared, having been superseded by the crank motion, which performs the office of the gears in a noiseless, frictionless, and rapid manner with but little resistance to the motive power. The general introduction of the crank motion has also hastened an improvement in the construction of the overhanging arm which hitherto had been almost universally cast with an opening in the side, necessitating a nearly solid arm beyond the space required for the insertion of the upper shaft. The arm thus made was heavy, unshapely, and, when in motion, capable of torsion sufficient to deflect the needle from its course, resulting in the breakage of needles by contact with the needle plate. The arm as now exhibited is generally a hollow arm of uniform thickness throughout—strong, symmetrical, and rigid, a protection against the escape of oil except to the drip pan, and free from all tendency to vibration or quivering.

In 1876 there were no exhibits of an oscillating shuttle, but in 1893 a large proportion of the exhibits of the Singer manufacturers contained that device. This shuttle is claimed to be a distinct advance, as the distance traveled by the shuttle is materially shortened, the friction diminished, and a shorter needle can be used in conjunction with it. The beak of the shuttle takes the thread at the highest point, which being directly under the bedplate of the machine makes it possible to use the shorter needle, which is a gain in the fact that rigidity is increased in the needle with diminished length.

It is also claimed that the stitch is made firmer, more even, and the "lock" is more certainly secured in the center of the fabric sewed. The reason assigned is that the stitch is drawn tight while both the upper and lower threads are in a perpendicular position and in juxtaposition, whereas in the vibratory shuttle machine the upper and lower threads travel in different directions and the lower thread is at an angle when the stitch is tightened. What is true of the oscillating

shuttle in this regard is also true of the rotary shuttle, which travels always in the same direction, while the oscillating shuttle makes a partial revolution and returns. The long-beak oscillating shuttle also possesses the advantage of taking down the slack thread necessary to allow the shuttle to pass through the loop at the time when the needle eye is out of the goods, and of taking up the same amount of slack thread when the needle eye is still out of the goods; this prevents the friction of the needle thread which occurs in drawing the slack thread when the eye of the needle is in the goods, and also admits the use of a finer needle to a given size of thread, and makes a firm seam resembling hand sewing.

Among the minor devices which are new since the Exposition of 1876 is the tension releaser, so called. When the end of a seam is reached it is necessary to pull down the needle thread before cutting it off preparatory to removing the fabric being sewed, and this was often attended with the breaking of the thread owing to the grasp of the tension disks. The tension releaser is a device, worked either automatically or by hand, which temporarily removes the pressure of the tension disks and enables the operator to draw down the thread with no more resistance than in drawing it direct from the spool. Thus is obviated the rethreading of the needle and putting it again in proper conjunction with the shuttle thread.

Another minor device is that for winding the thread from the spool to the bobbin, known as the automatic bobbin winder. This winds the thread onto the bobbin with the same regularity and precision as is displayed on the original spool, and is a great factor in obtaining a faultless tension. This, in connection with the wooden bobbin, which has also come into use since 1876, has practically solved the question of a perfect tension. The weight of the metal bobbin hitherto used interfered with definiteness because the weight of the device added momentum to its movements, which often produced unevenness in the appearance of the stitch, while the light weight of the wooden bobbin reduces the uncertainty in that direction to a minimum.

In 1876 a bobbin was filled by a device connecting it with the balance wheel of the machine, rendering it necessary to operate the machine as fully as when using it for sewing. The exhibits of 1893 show the adoption of a device, which, by the displacement of a pin or kindred method, the balance wheel is loosened so that it revolves on the shaft without turning it, and the bobbin is thus filled while the mechanism of the machine is silent, except the belt wheel and the balance wheel.

There has also been adopted in later years, as exhibited in 1893, a device for measuring the length of the stitch, which, while differing but little in the mechanism of the regulator, provides a scale, plainly marked on the machine at the proper point, by whieh the length of the stitch can at once be determined by a movement of the indicator.

It is also worthy of note that the "head" of the machine in former years was screwed, or attached, to the supporting table in such a manner as to render it a matter of labor to remove it when necessary for cleaning or repairs. The exhibits of 1893 show a distinct recognition of this primitive defect by the adoption of advanced ideas which enables the ordinary operator to disconnect the machine from the table without any trouble whatever; the principal of these devices consists of a hinged pin which is readily inserted in a socket prepared to receive it in the bed of the machine.

The belt wheel and belt, which ordinarily take the lowest seats in the home of mechanics on account of their antiquity and familiarity, also show the advanced thought of the last decade in the fact that the belt can be automatically thrown off or on by the movement of the driving wheel, and the annoyance of starting the machine in the wrong direction has been obviated by the introduction of a brake which prevents the driving wheel from moving except in the correct direction.

The driving wheel was long a source of trouble from the fact that the supporting tables or stands were so made as to enforce the use of "journals" inserted at the side of the stand and on which the wheel revolved; this method resulted in "lost motion," from which the "cone" device was evolved. The exhibits of 1893 show an almost universal adoption of the old principle of running the axle on centers, which not only take care of their own wear, but materially reduce the friction and lighten the operator's labor.

The chief distinctive departure from the old methods for supporting the machine "head" and providing space on which to place the fabric to be sewed consists of a stand or table containing a mechanical device which embraces something of the principle of the elevator, and by which the machine head is raised into position for work or lowered into position for protection from dust and dirt while idle.

By bringing the table leaf at the left of the operator into position for use, the head of the machine is moved vertically to its place, and is made secure and rigid by the operation of a spring so adjusted as to render it immovable until released by another movement of the table leaf, whereby it is returned to its position below the surface of the stand, and the leaf becomes the cover.

A number of exhibits of "drop cabinets" were made by manufacturers, and it is claimed that the unwieldy box cover is thus displaced, and a flat top or surface is given to the stand or table; this renders it both useful and ornamental, as a stand or table, when not in use for sewing purposes. The head of the machine is raised and lowered by means of automatic devices, as described in the stand or table previously mentioned.

It is also worthy of note that a very distinct advance has been made in the accessories or attachments for family sewing machines, particularly in hemming, plaiting, and embroidering fabrics, and the like; and

this field for displays of artistic inventive genius has been well and creditably occupied.

The exhibits of work done on various machines illustrate more fully than words can do the office of the sewing machine attachment. The displays of tucking, hemming, and especially of embroidery, indicate to what exalted and æsthetic realms the tiny pieces of steel mechanism can soar when deftly manipulated. Among the artistic displays of machine work which vie with the best oil paintings in perfection of execution may be mentioned the following: "Old Madrid," "An Ocean Dream," "Knighting of the Earl of Warwick," "Sleeping Beauty," "Monarch of the Glen," and "The Troubadour."

It is not the province of this paper to discriminate between manufacturers of sewing machines, or to undertake to allot to them the several degrees of fame to which they are entitled. The public, from which there is no appeal, usually performs that office, and the verdict of a generation is usually correct. It is sufficient for this purpose to say that all the exhibitors at the World's Columbian Exposition in this department were worthy and deserving of all the honors conferred.

So far as the exhibits of domestic machines and specimens of their work are concerned, speaking generally of the magnificence of the display as an exhibition, there seems to be but one opinion among those who have had an opportunity to draw conclusions from observation, and that is that the domestic sewing machine feature of the Columbian Exposition was as far superior in every way to the exhibits at Paris, Vienna, or the Centennial as the Exposition at Chicago as a grand whole was superior to any exposition heretofore held within the memory of man.

While many of the productions in artistic work showed a wide range of useful and ornamental merit complimentary to the machines and to the attachments, it must not be forgotten that the skill of the operator is also entitled to recognition for the beauty evolved, just as the strains evoked from the chords of a musical instrument depend largely on the soulful touch of the natural and trained musician.

In conclusion, it may be noted that of the four original inventors whose machines were protected by the famous coalition of nearly half a century ago, Isaac Merritt Singer was the only one whose name was commemorated by exhibits at the Exposition.

The following companies, named in the order of their age, were represented by exhibits of sewing machines for domestic purposes in the World's Columbian Exposition: The Singer Manufacturing Company, Domestic Sewing Machine Company, Davis Sewing Machine Company, New Home Sewing Machine Company, White Sewing Machine Company, Household Sewing Machine Company, Williams Manufacturing Company, National Sewing Machine Company, Standard Sewing Machine Company, Tracy Sewing Machine Company, Self-Threading Sewing Machine Company.

SILK EXHIBIT OF LYONS, FRANCE.

BY

H. L. GARGAN.

SILK EXHIBIT OF LYONS, FRANCE.

By H. L. Gargan.

My inspection of the various silk exhibits offered for examination having been completed, I went up to visit the French section, where are exhibited the best products of the silk industry of Lyons.

Involuntarily I compared in my mind the exhibits I had seen and the exhibits which were surrounding me. I must say that a comparison was scarcely possible, and I was amazed at the sight of the magnificent display of gorgeous silks made by the Lyons manufacturers, and I regretted that France had withdrawn and that no individual award could be given to many of those exhibitors who had spent a large amount of time, of brain work, and also of money to bring over here and show us the treasures of their manufactures and the skill of their workingmen.

I will in a few words speak of these exhibits which I closely examined and which made a very strong impression on me.

H. Gustelle shows us an exhibit of colored velvets combined with some rich plain silks and armures. The blending of the colors is very artistic and the whole display very attractive. His neighbor, Lemaitre & Guigne, presents a great variety of amber velvets and of velvets in all colors and qualities. The next exhibit makes quite a contrast. It is Tresca frères' show case, where I see their renowned plain black silks and satins and their handsome brocades in various combinations of colors.

J. B. Martin is the next on the list. He shows us his silk plushes for hat purposes; also his famous qualities of Persian lamb velvets. As an addition to his exhibit he has sent samples of the raw material which he uses in his manufactures.

This rather severe exhibit is followed by the one of Chanent père et fils, which is a real garden if we look at the lovely flowers executed on taffeta ground or on satin. This exhibit is one of the best.

E. Duchamp, who comes next, is a smaller manufacturer, but his efforts deserve a great deal of credit. So does the exhibit of Tabard, Cecillan & Chaput in their display of ribbons.

Arquische, Ravier & Graspillier have some very good brocades, but their exhibit does not show to advantage.

L. Permezel & Co., who have the next exhibit, demonstrate the

variety of the effects which can be produced in the dyed-in-the-piece goods. A man must be a connoisseur to appreciate this exhibit, which is the least attractive of all.

One of the most tasty exhibits is certainly the one of Brunet, Lecomte & Devay. They show their specialty in the printed warps with velours au sabre effects, produced on satin and also on satin strips, alternating with gauze bands of façonné.

J. B. Bonnet has some good crepe and gauzes, but the value of this exhibit disappears before the magnificent display of Panut père et fils. This manufacturer has shown the greatest of taste in the selection of his articles and of the designs which adorn his goods. He deserves a special mention, as he prepares and throws himself the raw material which he employs in his fabrics.

Jarranon & Laval have a large exhibit of their well-known gauzes, veilings, and other light articles. They show a great variety of fabrics, but their display could be arranged to better advantage.

A large black spot comes next. It is the exhibit of the famous black silks of C. J. Bonnet. The value of these goods is too well known to insist any more on the great merit of this exhibit.

Chatel & Tassinari have made a grand show of their manufactures for upholstery purposes, and they have sent some marvelous specimens of their fabrics. The grandeur of the designs and the beautiful combinations of the colorings make this exhibit a most admirable one.

Bardan & Rittan have presented to us some very rich plain goods in satin bengaline and have a woven ocean scene, for which they deserve a great deal of credit.

A. Rosset's display of veilings, gauzes, grenadine, and crepe is worthy of a special mention.

Next comes J. Bachelard & Co.'s exhibit. There again we find this wonderful skill, this marvelous intelligence, displayed in the fabrics which are shown by the manufacturer. His swallows on satin ground, his velvet clouds, and his reproduction on silk of the Niagara Falls make this exhibition certainly run an even race with two of the manufacturers already méntioned.

E. Cherillard & Co.'s exhibit of dyed-in-the-piece goods is certainly very tame compared to the latter.

Gautier, Bellon & Co. made a pretty exhibit of their all-silk velvets, which are their specialty.

The exhibit of J. A. Henry is a wonderful specimen of the art of weaving and also of embroidering. His church vestments are magnificent and the execution most perfect. His prayer book, woven in silk, is a work of art and deserves a most special mention.

The velvet exhibit of Riboud frères is good and the colors well harmonized.

H. Adam & Co. have brought to us their specialty of black damas and fancy gauzes, in which they excel.

Atuyn, Bianchini & Ferier made a good effort to render their exhibit attractive. They show some peculiar designs, and their combinations of brocades with velvets is very artistic.

Giron frères have made a large exhibit of velvet and fancy ribbons, which are their specialty.

J. M. Piotet & Roque show in their display that they have made a great effort to render their exhibit attractive by the variety of their articles, their numerous handsome brocades, and their skillfully executed upholstery goods. Their display is very artistic and denotes great care.

Gindre & Co. have only shown their various qualities of colored satins, which make quite a contrast with the showy exhibit of Biskest & Besson in their low grades of colored and black velvets.

Bauffier & Bravaz fils are the last exhibitors, and the various crepes, black and colored, which they show are very tastefully displayed.

This ends the list of the Lyons exhibitors. I have found that in all cases they have made special efforts to bring to us the best of their manufactures, and they deserve great credit for the handsome display they have succeeded in making in the manufactures building.

France having withdrawn from examination, the Lyons exhibits are not entitled to any award.

SUGAR AND OTHER SWEETS.

BY

GEORGE C. TAYLOR, LL. D.

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SUGAR AND OTHER SWEETS.

By George C. Taylor, LL. D.

Let us go back ages upon ages in geologic history to the flora from which our coal fields were formed, and there we may find the source from which has evolved during the past decade the sweetest substance known—saccharin—five hundred times sweeter than the sucrose of cane sugar. But saccharin is not a true sugar, although running parallel therewith in many of its uses; hence we will leave it in the hands of the man of crucibles, and atoms, and molecules, and chemical symbols, making at one bound a leap from geological to Biblical history.

According to Biblical history, Adam and Eve, 4004 B. C., raised a little bad Cain, were acquainted with fig leaves, and doubtless enjoyed the fruit of this plant, for it was pronounced good—good to eat. The fig, when thoroughly ripe and dried, contains 60 per cent of fruit sugar. Far be it from any feeling of irreverance, yet the reflection arises that our love of sugar has descended from very ancient ancestors, even though it may be slightly tainted by that other fruit Eve gave to Adam.

It is known that nearly four thousand years ago substances containing sucrose were used at feasts as food and as presents. In 1141 B. C. we find Samson eating honey gathered from the carcass of a lion with as much nonchalence as if it was no new thing with him at that date. While not admiring the style of vessel from which he took that honey, yet we can hardly be surprised, for at the time Samson was very much in love with another sweet—a woman in Timnath, the daughter of a Philistine. Do we not see man of A. D. 1894 acting equally as strange? Be all this as it may, I feel grateful to Samson in being the means of giving me the date, 1141 B. C., as one of the connecting links of time in this, my little sugar history.

Strabo says that sugar was found in the East Indies by Nearchus, admiral of Alexander, 325 B. C. Lucan asserts that an oriental nation, in alliance with Pompey, used the juice of the cane as a common beverage. Pliny said that the best sugar was produced in India. Galen prescribed sugar as a medicine about A. D. 160. While I am not disposed to deny the claim of the Chinese in being acquainted with the production of sugar three thousand years ago, I am inclined to think

their sweets at that date was derived, by very primitive methods, from a variety of grass which has developed into the sorghum of the present time. From all data at my command the probability is that the sugar cane of to-day had its origin in the East Indies. Sugar was brought into Europe from Asia A. D. 625, and in A. D. 1150 in large quantities. About 1138 the sugar cane was transported from Tripoli and Syria to Sicily and thence to Madeira. Its cultivation was attempted in Italy, but not succeeding, the Portuguese and Spaniards brought it to America about 1510, and it was in this century that the refining of sugar was made known in Europe. The first appearance of sugar in England seems to be 1497. A manuscript letter from Sir Edward Wotten to Lord Cobham, dated Calais March 6, 1546, advises him that Sir Edward has taken up for his lordship 25 sugar loaves at 6 shillings a loaf, "whiche is eighte pence a pounde." Refining sugar in England commenced in 1659. In Dresden as early as 1597.

The cultivation of sugar embodies two separate occupations: First, the agricultural cultivation of the plant from which the sugar is obtained; second, the mechanical methods of obtaining the juice from the plants used, and manufacturing the sugar. The method of extracting the juice is either by the mill process of crushing or that of diffusion. The mill process extracts from the sugar cane 60 to 80 per cent of the juices, according to the perfection of the mill work. Diffusion gives closely to 90 per cent, which is practically all of the juice; the woody fiber in cane averaging about 10 per cent. Commercially considered, our most important sugar plants are the tropical sugar cane and the sugar beet. The sugar from the sugar cane is the standard type of sugars known to chemists by the formula $C_{12}H_{22}O_{11}$. There are other sugars of the formula $C_6H_{12}O_6$, or glucoses. Cane or other sugar represented by the formula $C_{12}H_{22}O_{11}$, are so constituted that one molecule is equivalent to two molecules of the glucoses, minus one molecule of water; thus, $C_{12}H_{22}O_{11}$ equals $(2C_6H_{12}O_6 - OH_2)$. These will be noticed later, as they figure largely in commerce.

It has been proven that a large portion of the raw sugar of the East Indies received in British ports as cane sugar was in reality made from the juice of several palms, especially that of *Arenga saccharifera*, and the wild date, *Phœnix sylvestris*. The juice is obtained from these plants by cutting off the male spadix when young, and from the cut portion there is a continued flow of the juice for four or five months. The juice is at first clear and is then boiled down to a thick sirup, which granulates on cooling, and constitutes the coarse brown sugar called Jaggery. This is extensively used in India. Being more carefully prepared, it has been sent to Europe with sugar made on the cane plantations, and is only distinguished from it by experts. If the juice of these plants is not boiled it becomes turbid, and passing into the vinous fermentation becomes an intoxicant, a word which calls to mind

a quatrain from Porson, the ablest Greek scholar England has ever produced, thus:

I went to Strasburg, where I got drunk
With that most learned Professor Brunck;
I went to Wortz, and got more drunken
With that more learned Professor Ruhnken.

Although there are evidences of its very high antiquity in China and India, sugar appears only to have been vaguely known to the Greeks and Romans. Theophrastus speaks of "honey in reeds," and Lucan has the following line, which indicates a knowledge of its existence, but merely as a curious fact:

Quique bibunt tenera dulces ab arundine succos.

Until 1747, sugar (sucrose saccharose) was supposed to be the product of the sugar cane only, but in that year a German chemist by the name of Marggraf demonstrated that it was a natural product of other plants, and especially of the beet root. In 1799, M. Achard, a Prussian chemist, produced excellent sugar from the beet. In 1800, the French chemists, at the instance of Bonaparte, largely extracted sugar from the beet. After the fall of Napoleon protective duties kept alive this industry in France, and when numerous improvements in the cultivation and manufacture of the beet had raised its percentage of sucrose, it took a fresh start about 1825 in France and Belgium, was revived in Germany, and spread even to Russia. The falling off of the customs duties on the import of colonial sugar checked the industry for a time, but owing to the protection of Zolverein the trade soon revived. Fifty years later, 1875, the whole of Europe produced nearly 1,250,000 tons of beet sugar. Now Germany alone has 401 diffusion beet factories, her product of sugar in 1893 equaling that of the whole of Europe in 1875.

The great growth and prosperity of the beet industry in Europe is largely attributable to the increase of sucrose in the plant, the result of scientific research by the chemists, aided by national encouragement and protection.

The first experiments in America with beet sugar was in 1830 by two Philadelphians, followed in 1838 by Mr. David Lee Child making beet sugar in the Connecticut River Valley at a cost of 11 cents per pound. The industry in the United States really dates from 1863, by the enterprise of the Gennert Brothers at Chatsworth, Ill., the result of which was more educative than profitable. More recently, in California and some other States of the Union, it is being carried on with encouraging prospects of success, only needing a little fostering by the Government to make it the equal, if not the outstripping, rival of the sugar-cane belt in Texas, Louisiana, and Florida. The extraction of the juice from beets is accomplished by diffusion; the general principles of after treatment are somewhat similar to that of sugar cane. At the Exposition,

Nebraska exhibited a very high grade of beet sugar, the color, crystals, and flavor being equal to the finest sugar from the sugar cane. The total production of seven beet-sugar factories of the United States in 1893 was 44,953,024 pounds, exceeding the previous season by 17,869,702 pounds.

In the intensive, scientific, and skillful cultivation of sugar plants, Europe takes the lead with the beet. Next in order, as to careful and thorough cultivation, comes the sugar cane in the United States, this being demanded by its climatic environments. Sugar cane in a more tropical climate demands much less skill in cultivation, thus rendering it far less expensive, even if the price of labor was on the same basis. Up to 1800 the sugar industry of the Western Hemisphere was largely confined to the West Indies; now it is greatly expanding through Central and South America. With a reasonable protection from its own Government, the United States, in a few years, through its sugar cane, beets, sorghum, and the maple, would be able to raise all the sugar demanded for home consumption in North America. Upon a basis of 60 pounds per capita, the United States raises only about 10 per cent of the sugar consumed by its people.

My first ten days at the Fair were spent in making a cursory examination of exhibits of department A, group 3, all classes of which may be embodied in the one word, *Sugar*. The object of this was for formulating the best methods of examination and analysis of samples competing for award. There were all grades, from the highest to the lowest, and from all quarters of the world. Among the exhibits there were sugars from the sugar cane, beet, sorghum, maple, palm, cornstalk, milk, and grape, with glucose for varied commercial purposes. Probably the most beautiful refined sugar exhibited was from Italy, polarizing 99.9; yet this was so closely equaled by samples from Russia, Brazil, Cuba, Trinidad, British Guiana, United States, and other countries that it seems almost envious to make comparisons. While there were some very high-grade plantation sugars from the Tropics, they were equaled by the Louisiana plantations. From Mexico, Nicaragua, Venezuela, Guatemala, Costa Rica, and Argentina, there were sugars which, from their almost primitive methods of manufacture, were of very high interest. Most of these were very dark and in concrete masses, yet they possessed a rich sugar-cane flavor not found in their higher grades and refined sugar. A flattering evidence of the rich and pure flavor of these sugars is the fact that lady visitors at the Exposition often importuned me for my examining samples to eat as taffy, even in preference to the maple, for which latter there was sufficient demand to send an impecunious sugar judge "by the board." Although the sugar cane and beet are the great commercial producers of sucrose, yet the chemist finds sugar of some kind in almost every plant, and even flesh. Nearly all sweet-tasted fruits contain true cane sugar of the formula $C_{12}H_{22}O_{11}$ together with invert sugar; while others, as walnuts, hazelnuts, almonds, coffee

beans, the fruit of *Ceratonia siliqua*, or St. John's bread, contain only cane sugar. Honey and the nectars of flowers contain cane sugar, together with invert sugar. The sugar in the nectary of cactuses is almost wholly cane sugar, which fact is well known to the natives in Mexico to an intoxicating extent. The limits of this paper will not permit further mention of invert sugar other than stating it bears the same formula as glucose, $C_6H_{12}O_6$.

The douro, shaloo, sugar grass, Chinese sugar cane, or sorghum was unknown in America till 1857. Numerous varieties are now in cultivation. It has been grown from Maine to Louisiana with more or less profit by the small farmers for sirup and food for stock. An excellent grade of sirup for table use is easily made from it by simple methods and inexpensive machinery especially made for that purpose. Although the plant is rich in sucrose it does not readily give up its crystallizable sugar. There are many difficulties to overcome in its manufacture as sugar in crystals, yet even that is now remunerative in the large and expensive central factories especially adapted for its manufacture. Through the selection of seed by Government, State, and individual experiment stations the plant has been so improved that its sucrose content often exceeds that of the sugar cane. The greatest impediment to its proving a formidable rival in the United States to sugar cane is the obstinacy with which the plant refuses to give up its sucrose to crystallization; but the chemists are not idle and there are still good prospects of our yet seeing sorghum sugar manufactures of vast commercial values. The Government experimental sorghum stations, under the direction of Dr. H. W. Wiley, chemist of the Agricultural Department, have been worth to the industry ten times the cost of keeping up such, yet within the past twelve months they have been stopped.

From 153 analyses of amber and orange sorghum cane, ranging from September 1 to October 23, 1890, at Attica, Kans., the following showing is made, the samples representing field averages:

Sorghum juice.

Averages.	Sucrose.	Glucose.	Purity.
Means	14.26	1.53	71.91
Maxima	17.95	3.43	90.80
Minima	5.85	.55	35.83

Summary of 40 strikes of sorghum sugar between September 1 and October 24, 1890.

	Sirups.				Massecuites.				Sugars, sucrose.
	Solids.	Sucrose.	Glucose.	Purity.	Solids.	Sucrose.	Glucose.	Purity.	
Minima	43.50	27.44	6.87	56.30	87.70	50.20	12.50	56.60	84.40
Maxima	57.62	35.55	11.58	66.40	93	57.80	18.84	64.43	97.20
Means	50.67	31.21	8.65	61.59	89.69	55	15.45	61.20	93.50

These tables are condensed from Experiments with Sorghum in 1890, by H. W. Wiley, chemist of the United States Department of Agriculture, Bulletin No. 29, to which the reader is referred for valuable and extended information upon this subject. Comparing these results with the early prospects of the beet industry, they certainly present a very flattering prospect of the future of sorghum in becoming a confrère of the sugar cane and beet.

Glucose, dextrose, or grape sugar, $C_6H_{12}O_6$, is the crystallized sugar found in honey, raisins, and many other fruits. It is almost always accompanied by lævulose, which is far more difficult to crystallize and is isomeric with it. Dextrose is also found in small quantity in several animal fluids, and in the liver, and is abundant in urine in cases of diabetes.

Dextrose may be obtained from honey by mixing it with cold alcohol to dissolve the lævulose, but it is unnecessary in this paper to give further detail of its treatment. To obtain dextrose from fruits they are crushed with water, strained, the liquid boiled to coagulate albumen, filtered, evaporated to a sirup, and set aside for several days, when crystals of dextrose are deposited. Fresh fruits contain chiefly lævulose, which is sweeter than cane sugar and is gradually converted into dextrose. Dextrose may be prepared from cane sugar by acting on it with an alcoholic solution of hydrochloric acid and draining the solution of lævulose away from the crystals. The grand problem in the manufacture of cane sugar is not "how to prepare dextrose," but how to get rid of it in combination with its fiendish associates.

Commercial glucose or starch sugar as per the chemical books is made by treating starch with diluted sulphuric acid, which first converts it into the isomeric dextrin, which combines with the elements of water to form dextrose, thus:

Starch.		Water.		Starch sugar.
$C_6H_{10}O_5$	+	H_2O	equals	$C_6H_{12}O_6$

Water containing about 1.5 per cent of sulphuric acid is heated to boiling and a hot mixture of starch and water is allowed to gradually flow into it. The mixture is boiled for half an hour, neutralized with chalk, and concentrated by evaporation, when it deposits crystals of calcium sulphate. The clear sirup is drawn off and evaporated in a vacuum pan till it is strong enough to crystallize, which is accelerated by adding some glucose from a previous crystallization. The glucose thus obtained contains maltose, dextrin, and some calcium salts of organic acids; it may be purified by washing with strong alcohol mixed with 3 per cent of hydrochloric acid, and afterwards with commercial absolute alcohol. From an aqueous solution it crystallizes in six-sided scales; from alcohol in small needles. It is not as sweet as sucrose. Glucose or starch sugar when refined is not unhealthful, and pure cane sugar when taken into the stomach is converted into glucose before

being utalized by the human system. In the earlier days of the history of commercial glucose, my sympathies were strongly aroused in its behalf, for certainly there was a "hoot and cry" raised against it deserved only by a rabid "yaller dorg;" but it has stood through it all, and now the industry is one of vast and wide-reaching importance to various industries, and of enormous commercial value to the world. At the Exposition there were no more beautiful exhibits from a scientific standpoint than the glucoses exhibited by the Chicago Sugar Refining Company, and the National Starch Manufacturing Company of New York. A sample from the latter company so specially attracted my attention that, finding it proved to be of a refractive index of 1.503, I made some experimental optical tests, and found that, although very difficult to manipulate, it gave very beautiful results as an immersion fluid in microscopy.

The starch sugar or glucose industry in Germany may be dated as having its origin in Kirchhoff's experiments in 1811. After meeting with many obstacles, its onward progress was such that we find it of commercial importance as early as 1830. The production of starch sugar of various grades from 35 factories in the German Customs Union in 1881–82 was 38,877 tons, the selling price being an average of $68.39 per ton.

According to the census of 1880 there were in the United States 7 glucose establishments having a capital of $2,255,000, employing 1,192 hands, paying $605,802 in wages annually, consuming of materials $3,044,450, and producing $4,551,212 in finished goods. After 1880 there was a sudden and great increase in the number and capacity of glucose factories, so that in 1883–84 the National Academy of Sciences, as stated in their report, found 29 factories. At that time the number, including most of the smaller ones, for various causes, whether owing to imperfect process and machinery or inability to compete with the larger works, went out of business. The census of 1890, owing to the failure of many glucose factories to report, is incomplete and comparatively worthless for purposes of accuracy. The following figures regarding the industry in the United States, although partially estimated, may be taken as approximately correct:

Number of glucose factories	11
Capital invested	$11,000,000
Daily capacity, bushels of corn	61,000
Annual capacity, bushels of corn	19,032,000
Acres of land required to raise corn, at 26 bushels to the acre	732,000
Farmers required to raise corn, three men per 100 acres	21,960
Annual capacity, pounds of glucose	570,960,000
Value of glucose per annum	$14,274,000
Laborers employed in factories	4,575
Wages paid annually	$2,058,570
Average daily rate of wages	$1.50
Exported in 1885 ..... tons..	912
Exported in 1893 ..... tons..	50,773

There are a great many other by-products of the glucose factory of great commercial interest and value, among which are gluten, gluten meal, and other stock food, all of which take a very prominent position commercially. Many of these fell under the individual examination of the writer during the Exposition, finding them of great purity chemically and true to the scientific formulæ upon which they were claimed to be based. The stock food he has seen practically in use on sugar plantations, giving good results as a diet for working mules and at the same time economic, a fact strongly appealing to the planter's pocket. As a fair general type of a plantation sugar house in Louisiana and the Tropics at the present date, I give a somewhat detailed description of one at Poydras, La. The capacity of this house is equal to the manufacture of from 2,000,000 to 3,000,000 pounds of sugar. The building is a slated roof brick structure in the form of a T. The main body is 150 by 50 feet and two stories high, surmounted by a cupola 12 feet square and 10 feet high. The two wings forming the top of the T are each 80 by 30 feet and only one story, one being a hot room and the other for weighing, storage, etc. Attached to the main body of the building is an open slate-covered cane shed 100 by 60 feet. Between the cane shed and one of the wings there is a two-story structure, 36 by 24 feet, connecting with the main body of the house, and contains the triple effect, sirup tanks, vacuum, and other pumps. On the opposite side of the main body are two buildings, one containing a battery of 4 four-flue steam boilers, 36 inches in diameter and 30 feet long; the other contains 3 two-flue boilers, 34 inches in diamter and 32 feet in length. Between these two boiler houses, attached to the main house, is a bagasse furnace, in which there are 8 cylinder steam boilers respectively 28 and 32 inches in diameter by 50 and 42 feet in length. In proximity to these is an 85-foot brick smokestack, also a large iron water tank elevated 50 feet. In the roof of the cane shed are three large filter presses, one German and the other American make, through which all skimmings, sediment, and washings from sirup and other tanks pass. Nothing is wasted, even the solid mud cake from the filter presses being returned to the fields.

The canes from the field being brought to the cane shed are placed upon an endless carrier, 5 feet wide, which after traveling onward and upward about 125 feet fall into a three-roller mill, each roller being 28 inches in diameter by 6 feet in length. From this mill the crushed cane falls upon another carrier and is sprayed with water at a temperature of about 140° F. during its passage to a two-roller mill, the rollers of which are 40 inches in diameter and 6½ feet long. This mill is supplied with a hydraulic regulator giving a pressure so great that when making an extraction of 80 per cent the crushed cane, now called bagasse, is almost dry as it falls upon a third carrier taking it to an automatic feeder which supplies it to the bagasse fur-

nace previously referred to. In some of the sugar houses of this class a crushing or shredding machine is affixed above and in advance of the first mill. In larger houses it is not unusual to see the first mill supplemented with two or three mills, and in exceptional cases may be found a double system of mills and carriers, thus preventing a stoppage in case of a breaking of one of these iron monsters, which occasionally happens, wrenching off a 13-inch wrought-iron shaft as if it were a mere plaything.

The juice from the mills passes through a straining trough to a tank below, from which it is pumped to a machine in the roof, where it is impregnated with sulphurous-acid gas, SO_2, which bleaches and also tends to coagulate impurities. From this machine it passes to an iron tank, supplying it to eight clarifiers. These clarifiers, placed upon a gallery midway between the second floor and roof, are iron tanks holding 750 gallons each and are fitted with steam pipes in the bottom. After the juice is run into the clarifier, it is treated with milk of lime to neutrality and heated to about 200° F. for a few moments, when a thick muddy scum arises. This, in sugar-house technics, is termed a blanket, and with a little coaxing by sweeping it with a long flat paddle it runs over one side of the clarifier especially constructed therefor into a trough, taking it to a skim tank on the first floor. The heat is now lowered and the clarifier left to further settling, when it is drawn off to one of two evaporators, when, in houses not having a multiple effect, it is boiled down to a sirup of a consistency suitable for the vacuum pan, say, about 25° Baumé, which is equal to about 45 per cent of sugar. These evaporators are situated below the level of the clarifiers and are large copper kettles with steam coils in the bottom. In this house they are used only as adjunct or supplementary clarifiers. The clarified juice is now taken to a large tank below to be supplied to the multiple, in this case a triple, effect for evaporation into sirup. Just here I must digress a little.

A high temperature tends to destroy the sucrose in cane juice. In an open pan at sea level water boils at 212° F. Weak cane juice begins to boil a little above this, and demands an increased temperature in proportion to its concentration. In a pan where the barometer registers a vacuum of 30 inches, weak cane juice will boil at a little above 100° F., temperature increasing with density. Utilizing these facts, the multiple effect is a mechanical invention by which the heat of the vapor arising from the juice boiling in pan No. 1 can be used in pan No. 2, and so on, up to a third, fourth, or fifth pan, depending practically upon the increased vacuum of each successive pan. The triple effect in this, however, consists of three cylindrical iron pans with hemispherical top and bottom, 12 feet high and, respectively, 8, 8½, and 9 feet in diameter. Within each pan is a system of steam or vapor tubes for heating. The three pans are appropriately connected

by devices by which vapor, juice, and vacuum can be varied in each pan. The practical operation is briefly this: The clarified juice is run into pan No. 1, under a vacuum of about 14 inches. The exhaust steam from the engine and other sources of the sugar house is turned into the steam tubes of this pan, and the juice boils at 180° F. Into pan No. 2 the partially concentrated juice from No. 1 is boiled to a semisirup by the vapor from No. 1 at a temperature of about 162° F., vacuum of 19 to 20 inches, and so on into No. 3, in which it is boiled to about 50 per cent sirup by a temperature of 140° F., under vacuum of 25 to 27 inches as registered by the vacuum gauges. In connection with the triple effect there are large vacuum and sweet water pumps and condensers. The value of such a multiple effect is about $20,000, yet it is the greatest money saver among the comparatively modern improvements of the sugar house, in contradistinction to the primitive open-kettle methods. Aside from all chemical advantages of the multiple effect, it pays for itself in the saving of fuel.

The sirup from No. 3 of the triple effect is run into a large iron tank, where it awaits the demands of the vacuum pan, in which it is boiled down to about 75 per cent sugar by 140° heat and under 28 to 29 inches vacuum gauge. The sugar is discharged from the vacuum pan into a large mixer, which delivers it to three centrifugal machines that throw out the molasses into a suitable receptacle, from which it flows to the molasses tank, leaving in the centrifugal a "firsts" or white sugar, which is automatically taken to the cooling room for packing in barrels. The sugars of this class are called "firsts," in contradistinction to sugars made from molasses instead of sirup, called seconds, thirds, etc. The molasses from the thirds is boiled to a given density and run into portable tanks called sugar wagons, and left for several months in the hot room, when a small-grained and dark sugar is obtained. The molasses drained from this is almost worthless, yet it will be referred to elsewhere.

Drainage and fertilization are important factors in the cultivation of cane, but I leave these for the individual specialists.

I shall spare the reader the infliction of pages of statistics, merely stating that the few I may give are derived and condensed from a vast number of consular reports and sugar exhibitors from all nations at the World's Columbian Exposition. The beet-sugar crop of the world for the year 1880–81 was 1,774,545 tons; the cane-sugar crop for the same date, 1,979,900 tons; other true sugars, maple and sorghum, about 25,000 tons, giving a total of 3,779,445 tons as the world's output of sugar for 1880–81. At the close of the great Exposition in 1893, I make the world's output of beet, cane, maple, and sorghum sugar for 1892–93 as 6,330,000 tons, being an increase in twelve years of over 67 per cent. At the low valuation of 3¼ cents per pound, the world's sugar crop for the year 1892–93 represents a value of over $400,000,000.

In connection with these statistics, I abridge from the Extra Census Bulletin of the Department of the Interior, Washington, D. C., February 20, 1894, as follows: "Manufactures, sugar and molasses, refining, value of products, $123,118,259."

This census bulletin is of very great interest and should be in the hands of every manufacturer in the United States, and given very careful thought and earnest study in detail. The island of Trinidad, with an area of 1,754 square miles, exported, during the ten years preceding 1893, 810,941,174 pounds of sugar, valued at $22,521,900. The progress of sugar-cane cultivation in New South Wales is from 4,002 acres in 1870 to 22,262 acres in 1891. In 1873–74 Germany had 337 factories, of which 80 were diffusion, 214 pressing, and 43 other methods, turning out 291,041 tons of raw beet sugar. In 1892–93 there were 401 factories, all diffusion, which turned out 1,175,137 tons of sugar. Brazil in 1892–93 made 1,768,474 sacks of cane sugar of about 75 kilograms, or 165 pounds, each. The industry here dates back to 1532. In the Consular Reports, United States, volume 43, may be found an interesting history of the Russian beet-sugar industry, with valuable statistics, by J. W. Crawford, consul-general, from which I merely extract as follows:

> The first factory in 1802. The number of acres in cultivation in 1890–91 was 712,591; number of factories, 223; sugar produced, 9,112,137 hundredweight, being a percentage of 9.73 of the beets used.

It is difficult to get late statistics of sugar in Mexico. In 1889 the value of refined and raw sugar, including brandy made from the molasses, is stated at $14,731,865. The area of land in Hawaii under cane cultivation in 1891 is estimated at 67,849 acres, from which the exported sugar reached 292,083,500 pounds.

Technically, in the cane-sugar manufacture sirup is simply the cane juice boiled down to the consistency of a sirup, while molasses is drainage from masse-cuite, concrete or raw sugar. When the molasses is separated from the sugar by the use of centrifugal machines it is called centrifugal molasses. The molasses dripping from the hogshead of the primitive open-kettle process is rich in sucrose and may be safely used as a table molasses, but is rarely to be found at the family grocery. Molasses, after being worked over and over by reboiling and recentrifugaling, is very low in sucrose, and simply abominable for any domestic use except to be placed among the purgative drugs of the "plantation mule doctor." Does the confiding housewife ever suspect that her beautiful sirup or molasses from the "corner grocery" may not practically be far different from the following not altogether imaginative formula, thus: One-fourth barrel poor cane molasses, to flavor; three-fourths barrel fair glucose, to give body; saccharine, sufficient quantity to sweeten; zinc or other poisonous compound, quantum sufficit ad libitum, to bleach. Shake the barrel

and you have a sirup far more injurious to the nervous system than the rum and brandy made from molasses in the sugarhouses of the Tropics. This leads me to "distillation."

The lower grades of molasses are very largely utilized for distillation in the West Indies, Central and South America. It was at the Guatemala exhibit, I think, that I saw—yes, tasted, and in fact drank—a sample of the Central American sugarhouse product, finding it superior to some of our Kentucky bourbon and the so-called French brandy grown and manufactured in the United States.

The cultivation of maple sugar has been carried on in England and Europe, but not equaling that of the northern portion of the United States and Canada. The recent bounty of the United States Government gave a great impulse to the industry. There are very few complete official statistics, yet from information gained at the Exposition and other sources, it is within the limits of approximate accuracy to say that the annual value of the maple crop has increased during the three years previous to the Exposition from $5,000,000 to $10,000,000. We have no date anterior to 1752 as the origin of the industry. I hardly think the North American Indians knew anything about it, from the fact that they were ignorant of the fashion of "not going home till morning" from the effects of fermentation, until taught by our forefathers, proving themselves apt pupils, taking the fire water with a relish not surpassed by the good old days of "apple-jack" in my native land of steady habits—New England.

Rock maple is considered the best sugar variety, the sap yielding about 3 per cent of pure sucrose, sometimes running as high as 10 per cent, at which times the quantity of sap is less. To obtain the sap the tree is tapped early in the spring, before the winter frost has passed, to a depth of three-fourths of an inch, and afterwards to about 2 inches. Four gallons of sap yield about 1 pound of sugar; a single tree from 2 to 5 pounds. The best maple sugar at the Exposition was not the whitest. After an examination of over 1,000 samples the fact was revealed that all bleaching of maple sugar beyond a light brownish yellow color was a sacrifice of its pure, rich flavor, its greatest distinguishing point of merit. A very marked progress is being made in improved machinery and methods of manufacturing the sap into sugar.

I have in my mind a sample polarizing 85°, which, taking every point of excellence into consideration, was the best at the Fair. It was made by a plain old farmer, who never dreamed of an award. Of course he, among others, received an award, but not as the best of all, for the standard of award in this group was "excellence showing progress," and was conscientiously adhered to, irrespective of the individual opinion of the exhibitor.

The address of Miss Katharine L. Minor, of Louisiana, before the

Agricultural Congress in Chicago, October 9, 1893, so ably pictures sugar cultivation that I requested permission to copy it in full, as it originally appeared in the New Orleans Picayune. Miss Minor was one of the lady commissioners of the World's Fair, and is well known as one of the ablest sugar cultivators in the United States.

Miss Minor's address reads as follows:

Mr. President, ladies, and gentlemen: A distinguished honor has been conferred upon me to prepare for your edification a paper upon the economical production of sugar in the State of Louisiana.

May I first say to you that my claim upon your attention to-day is based upon the fact that I have lived all my life on a sugar plantation, and for a number of years have been an active partner with my brother in the absolute cultivation of sugar. The property upon which we live is an inheritance, and was developed by my father, who entered it in 1828, and so with the information I have gained traditionally, and that which I have acquired practically, causes me to present to you a history of the growth of sugar in the State, covering a period of a number of years.

I shall not weary you by telling you much of its past history. The industry has had its vicissitudes, its ups and downs, like every other industry, the details of which would be interesting, no doubt, to those actively employed in its development, but tiresome, perhaps, to those who are only incidentally connected with it.

Sugar cane is an exotic brought from the West India Islands. It is of the genus grass, and is produced not by formation of seed, but by planting the original stalk, which has to be renewed every third year, while in the islands, under more favorable climatic influences, this renewal does not take place oftener than once in twelve or fifteen years. It was introduced into Louisiana a little over a century ago, and is grown exclusively in the lower section of the State. It is a hardy plant, enduring great extremes of moisture and drought, but is very sensitive to cold, and is killed at 32° F.

It was found that cotton did not produce satisfactory results in this section. The strength of the soil and the dampness of the climate caused it to produce very large plants, but little or no fruit, and so very early in the century sugar became the staple product. Under slavery the vast sugar estates were developed very rapidly and grew in importance to a remarkable degree. The lands were new and the soil wonderfully fertile. The great advantages they possessed became attractive to men from France, Spain, and from the older States of the Union, and the district soon became peopled with a very intelligent class. Wealth was easily acquired. These estates were most remunerative. The rapid acquisition of wealth enabled the planters to enjoy a great many advantages, such as travel and surrounding themselves in their homes with many luxuries. Upon the walls of their residences were hung rare and beautiful works of art from European cities, while the furnishings of their houses came from France and England.

To be a successful planter, one has to possess a great fund of information. He has to be possessed of some chemical knowledge; he has to be a good machinist; he must have some knowledge of medicine, as a physician lives many miles away, and he is often called upon to perform surgical operations in the absence of a more skillful hand. He must be possessed of a good deal of legal information, as he often occupies the position of both judge and lawyer, and preeminently he has to be an agriculturist. The standard is also very high for his social attainments, and in every home is to be found a well-selected library.

The plantation was managed by an agent, who in antebellum days was called an overseer. He, however, was simply an executive officer, for it was the planter himself who gave the most minute attention to detail, and upon his ability, of course,

rested the success of his undertaking. The plantation seldom contained less than 500 acres of land, and sometimes exceeded 10,000 acres, and with the absolute care of the slaves one can easily imagine the position was not a sinecure.

But there came a sudden, and, I may say, an untimely end to all this. The war, which devastated the South, was especially felt by this class of its citizens, and when the great strife was over (a struggle which will go down to generations showing that the North had met a worthy foe, but the odds were against the South. Perhaps a divine intervention intended that defeat should follow the Southern army, for we all must admit that slavery exerted a very potent influence in causing the great rebellion). But we will not discuss this mighty question; it has been settled for all time to come. Although the generation who owned these estates were in no way responsible for its establishment and felt the most solemn responsibility in dealing with it; still, when the slaves were freed and peace was declared, the owners of the property returned home from the Southern army, oppressed and heartsick over their defeat, to find their homes and property destroyed by the necessary devastation of war; slaves and provender all gone, with no money, I can assure you stout hearts quailed at the prospect which surrounded them before beginning anew.

Nothing was left for them to do but to take hold and begin life over. Then came the trials of a new régime. The older men seemed entirely unable to cope with the changed conditions. Slave labor was to be replaced with the free; a new system must be inaugurated; their plantations rebuilt. However, sugar commanded a good price, from 12 to 13 cents a pound, and with a protective tariff for revenue, a war debt to be paid, the planter went to work in earnest and with a hope of rebuilding his lost fortunes.

Therefore, we may say that in 1865 was the beginning of the new era of sugar making in the United States. Since that time a great change has taken place. It was soon discovered that the old process of making sugar in large caldrons or kettles must be abandoned. It required from 4½ to 5 cords of wood to make 12,000 pounds of sugar by this process. The old method must be done away with and a more economical process must be resorted to. The planters formed an association; an experimental station was created; authorized agents were sent to Germany, a country which has spent many thousands of dollars to develop the beet-root sugar industry, and from these painstaking people much valuable information has been acquired. For, after the saccharine has been extracted from the beet, we find the same principles involved as in the treatment of the saccharine extracted from the sugar cane, which enabled us to apply to our own use a great deal of the information which we had borrowed from these more favored investigators.

The drainage of our land was made a study. A better system, employing the use of tiles, is becoming quite general, and, though still very costly, is found most desirable.

There arose a great demand for improved farm implements, which was met by the invention of a number of labor-saving tools especially suited to our use. These found ready purchasers in the planters.

The subject of fertilization has also been most closely investigated. Cotton-seed meal, the refuse from the large pork-packing establishments of the West, tankage from large cities, chemical fertilizers made after formulæ especially suited for our soil were introduced, and now almost every planter uses from 400 to 600 pounds of fertilizers to every acre of cane.

Next to be considered was the sugar house. The old machinery must go; the new must take its place. The diffusion process must be tried; the bagasse burners must be able to convert the refuse from the cane into fuel; steam must be used over and over again, and the great central factory must take the place of the small sugar houses, with their horse mills and small rollers. With a defective extraction in the old days, 60 per cent of sugar was extracted; in the new, 90 is obtained. The sugar house or

refinery must be run under the surveillance of a first-class chemist, with his laboratory and polariscope, and he decides what cut of cane must be ground first, so that the portion that was not entirely ripe can be left to enjoy a lengthened season and improve its condition, in this way alone often saving to the planter a great many pounds of sugar to the acre. The chemist also has worked wonders in the purification and treatment of the juice after it has been extracted from the sugar cane.

During this progress in the development of the industry, sugar was growing cheaper all the time. The islands of the Pacific and Atlantic oceans were being developed and the sugar from Hawaii was sent into the ports of the far West free of duty. A long peace in Europe enables France, Germany, Belgium, Austria, and Russia to increase their protection of sugar to a phenomenal degree; and so it has been most difficult for the industry in Louisiana to keep pace with all these. But we should not yield. We must advance. We must meet the requirements. Labor became somewhat disturbed, strikes took place, and all these annoyances, but obstacles were surmounted. Onward, not backward, was the watchword of the planter. Congress did not always legislate favorably to our interests. The constant agitation of the tariff was most depressing, and caused capital to withdraw from this section. This only made the planter learn to get on with less money. He must produce more corn and hay for his stock and become self-sustaining in every way. Stimulated by these experiments, he has met the demands with the following results:

One man can produce, with improved farm implements, 10 per cent more cane in 1892 than he did in 1860. In 1860 the average per acre of sugar produced was 1,500 pounds. In 1892 very nearly 3,000 pounds was the average; and let me here state that the most favorable circumstances produced 7,000 pounds, showing that in the very near future the average will still be increased. Six thousand pounds per acre was not an uncommon result for plant cane in 1892. I give this as my personal experience, that several hundred acres on our Southdown plantation yielded an average of 5,000 pounds to the acre.

In 1860 an acre of land yielded from 10 to 15 tons; now it often reaches 40 to 50 tons. In the same ratio the extraction of sugar per ton is increased. In 1860 eighty to one hundred pounds per ton was considered good results; in 1892 it reached as high as 200 pounds to the ton. All this increase is the result of new methods and most careful study and experiments, which have cost the planter many thousands of dollars. The old process required the canes to be pressed between 3 large rollers—now 8, 10, and 12 large rollers are employed where diffusion is not used. The burning of bagasse and using the same as fuel lessens greatly the expense of the plantation. On a place yielding from three to five million pounds of sugar, the conversion of this refuse into fuel saves from $5,000 to $8,000 per year. One hundred millions of dollars is invested in sugar machinery in Louisiana. The bounty has stimulated the expenditure of money in this direction.

In no part of the United States is cultivation more absolutely perfect than on a sugar plantation. The plantations are worked with a degree of neatness that would suggest the kitchen garden. The land is plowed and prepared in the fall of the year—broken up very deeply with a four-mule plow. It is then laid down in rows, 6 feet apart, the bed being carefully arranged for the reception of the stalk of cane, which is laid down in this way: Two stalks and a lap being allowed as the proper quantity of sugar cane to be used as seed. It must be remembered that this seed is exceedingly expensive, as 1 acre of cane, under the most favorable circumstances, will only plant from 5 to 6 acres. Therefore much of the crop must be saved for the seed of the ensuing year. The cane is covered with about 4 inches of dirt, which is a sufficient quantity to prevent the frost from descending into the ground. The cane can be planted from October any time during the winter months until the middle of March, when the dirt is carefully removed by degrees and the cultivation for the ensuing year begins.

Mules are entirely employed on the plantations, and give the most satisfactory results, having great powers of endurance and standing the Southern climate much better than horses, so that the plowing and work on the plantation is done with them. They are especially suited to the negroes—they seem to have a mutual understanding. The mule is an intelligent animal, and, while he is nothing like as fast as a horse, he will not submit to having himself overworked. He grows stubborn when he thinks he has performed a sufficient amount of labor, and no amount of urging seems to make the slightest impression upon him. He is exceedingly docile, with the exception of sometimes being a little careless with his hind feet.

The cultivation continues until July, when the crop is said to be laid by. The middle furrows are plowed very deep, and a good ridge is left to the cane to nourish it during the rest of the growing season. These deep furrows between the rows help to keep it well drained and convey the water to the cross furrows, which take it to the half-acre ditches, these ditches conveying it to the large canals on the lowest parts of the plantation, where it runs into bayous, swamps, etc.

Sugar cane looks very much like corn in the beginning. For a long time but one little stalk appears, and at each joint grows a little yellow, and during the month of May does not seem to grow at all. This is known as the suckering period, and the original stalk will often have around it ten or twelve suckers. But all these suckers in a short time catch up with the original stalk, and when the harvest season arrives there is no difference in the size of them.

The stubble cane is treated slightly differently from the plant cane. It has now been found that by shaving off the old stalks early in April, and then digging out the stubble by machinery, very much better results are obtained than with the old modes of cultivation. This is done to expose the eyes to the sun, which causes them to germinate more rapidly. From July to the 1st of September a rainy season sets in, from which the sugar cane seems to draw its sap. Then comes a dry September, which the planter is enabled to employ in harvesting corn and pea vines. One-fourth of the plantation is planted in corn and cowpeas. The latter are used to renew the soil, just as buckwheat is employed in many of the Northern States; but by having the pea vine raked and preserved as hay one of the finest materials of provender known is thus produced. And not only does the pea vine supply all the hay of the plantation, but it performs the double service of improving the condition of the ground. In many instances the pea vines in August are plowed under. This, of course, is more desirable; but even without this great good has been rendered the ground simply by the pea vine shading it, and the roots, which run down very deeply, bringing up to the top the nourishing qualities of the soil especially suited to the wants of the crop of cane in the year following.

The harvesting season begins on the 1st of October and continues until the middle of January. The cane is cut and hauled in large, four-mule wagons and three-mule carts. But this system is also becoming a thing of the past, and portable railways are being employed to great advantage, which will make the harvesting season very much easier, as the alluvial soil of Louisiana soon cuts and the roads become impassable under the influence of a rainy fall.

From the middle of November the planter is liable to freezing weather, which of course has a very disastrous effect upon the standing cane. He then windrows his crop, which is done by cutting the lower end of the cane and allowing the whole stalk with its luxuriant supply of leaves to cover the bottom, making it quite impervious to the cold. This adds a small proportion to the expense, but that is overcome by the great advantage obtained in preserving the cane free from the effects of the cold. Cane laid down in windrows will produce sugar for two months after it is cut, with desirable results. If the weather should continue extremely dry, occasionally it deteriorates, but even this detrioration would not be equal to the loss to the planter if the crop had been subjected to the effects of freezing cold weather. Under

the old system, cane would not make sugar more than a week after it had been subjected to 30 degrees, but under the new process our season is lengthened fully two weeks, which is a great gain to the planter.

The seed cane is preserved by cutting down and laying in furrows and being covered by about 4 inches of earth. As soon as the harvesting season is over, they open these furrows and remove the cane and plant it immediately. Many of the planters pursue the plan of planting a portion of the crop in the early days of October. Some good results have been obtained from this method, but it is not yet positively decided whether the fall planting gives as good results as the canes planted in January and February.

When the refinery is ready to begin its work large numbers of hands have to be employed, for it takes a great addition to the plantation force to harvest its crop. This gives employment to a great many white men who come down from the West after the harvesting season is over there; also to numbers of Italians who find it remunerative to come all the way from Italy to spend four months in Louisiana and return to their homes. The wages vary in the different departments in which men and women are employed. Skilled labor receives the same remuneration in Louisiana as it does in other States. For instance, head engineers are paid in proportion to what engineers in any other factory would receive. The ordinary laborer receives from 75 cents to $1 a day, while the women receive 60 cents, and children from 30 to 40 cents. This is for the cultivating season. During the harvesting times men receive $1.25 a day, and 75 cents for half a night. This would seem, at first glance, to be less than the laborer performing the same amount of services in the North would exact for his time. But when it is taken into account that the planter provides an excellent house, a garden spot, a yard, the privilege of the keeping of a horse, cow, and pig on the pastures of the plantation, and also providing the laborer with fuel, and giving him many other privileges, it will soon be understood that the laborer has only a portion of his food and clothes to buy. And so we feel that he is a peasant who should regard himself under the most favorable circumstances.

I should like to state that if the lands suitable to the growth of sugar in Louisiana were all developed, Louisiana would be able to produce very nearly the amount of sugar consumed in the United States, which is 60 pounds per capita. It has also been demonstrated that there are admirable lands in Texas and in Florida which might be made available for the production of sugar, and it has been stated to me by persons who have made close investigations that there is more land in the United States suitable to the growth of beet sugar than in any country in Europe. To this fact I should like to call the attention of the Western farmer. In Nebraska, in California, in the State of Washington, and in many other States in the West the lands are found suitable for the production of sugar beets. This would give employment to thousands of people, and would be of great help to the country in retaining the gold, which is now sent out in millions to foreign countries to pay for the sugar which is used to-day. All of this could be kept in the United States if these matters were given careful attention and the development of sugar was to be more thoroughly undertaken. It is well known that in no country are there beet farms; but the farmer simply plants a certain portion of his land in beets every year. The central factories spring up all over these localities, and the farmer finds ready purchasers in them. In this way he is enabled to obtain ready money for the use of his family at that season of the year when he has to sacrifice his cereals at very low prices.

The preparation of the land for beets has to be so carefully done that the crops which follow the beets are greatly improved by the same. I was in hopes of having this subject ably presented to you by Mr. Oxnard, who is the owner of three of the largest beet-root factories in the United States, and it is a great regret to me that he is not here to talk on this important question for the consideration of the farmers

who are present with us to-day. But I trust at their leisure they will give this matter some consideration, and I urge upon them to do so, feeling sure that they will find the most admirable results in introducing the growth of beets upon their western farms.

In conclusion, I would like to say that the sugar planter is not only an agriculturist, but he must also give attention to all other industries which are essential to the success of his plantation. Many of the large estates saw and dress all the lumber that is used for building purposes, and so large carpenter shops, filled with admirable mechanics, are kept occupied the whole time, while the packages in which the sugar and molasses are packed are made in the cooper shops. For the barrels in which the sugar is shipped the dressed hoops and staves are sent down from the West, but the molasses barrel is made from the cypress which is grown in his own swamps. And when it is considered the many thousands of these packages which are used in a year, it will be understood that many men are employed in these different departments. The blacksmith shop is also well equipped. Every appliance for pipe fitting and mending the quantities of machinery employed in the factories must also be at hand.

We depend upon the Great West for our breadstuffs, on the East for our shoes and wearing apparel, and on the East and West for our machinery and farm utensils. And so it would seem to me a just dispensation of Providence that while the other States yield to us our requirements in these directions, it is left to Louisiana the privilege in return of sweetening the United States.

Having furnished the reader with a pleasant time in reading the foregoing very interesting address, I will now describe some microscopic investigations of sugar.

Whether it be true or not that the microscope is a "hobby-horse," the reader will please pardon my mounting thereon for a few minutes in the interest of the sugar industry. There has been known for twelve or fifteen years a formidable enemy in the beet-sugar houses—a bacterium, bearing the name of *Leuconostoe mesenteroides*—and such a rapid worker that 49 hectoliters (about 1,290 gallons) of molasses, containing 10 per cent of sugar, have been converted within twelve hours into a gelatinous mass. It had been supposed that the cane-sugar industry was exempt from such an enemy until 1892, when, after six years of patient research under the microscope in this direction, the writer was rewarded by discovering, isolating, and proving by artificial cultivations the existence of a somewhat similar bacterium injurious to the cane-sugar industry, giving it the name of *Bacterium sacchari*. A full report of this was made to Prof. W. C. Stubbs, Ph. D., director of the Audubon Park Sugar Experiment Station, New Orleans. (Vide the Louisiana Sugar Planter and Manufacturer, Vol. IX, No. 13, September 24, 1892.) I quote, for the professional expert, one of many conclusive tests, as follows:

To a 10 per cent sterilized gelatin solution I added 10 per cent c. p. cane sugar, and, after inoculating the solution with a pure second generation of *Bac. sacch.*, the test tubes were plugged with cotton, placed in a sterilizer, and subjected to a temperature from 214° to 220° F. for an hour. After about two weeks I found enough of the bacteria to inoculate a whole Louisiana sugar house; also a gummy mass, microscopically identical with that from which I first obtained my first pure generation of

Bac. sacch. Careful chemical analysis by Prof. J. T. Crawley, of this (Audubon Park) experiment sugar station, showed 50 per cent of the c. p. sugar lost. A sample from the same source two weeks later by chemical analysis gave no trace of sucrose, no appreciable indication of ferment, but a mass of gum and *Bac. sacch.* in dormant state, as if half starved from lack of suitable pabulum.

The best preventive of the ravages of these bacteria in the cane-sugar house is absolute cleanliness and a rapid manufacture of the cane juice into sugar crystals. Notwithstanding these bacterial fiends of the sugar industry, there are other bacteria that are rapid and faithful workers in behalf of the sugar planter. On the roots of pea vines, clover, and other leguminous plants there may be seen, without the aid of a microscope, small, white nodules. Now, by the use of the microscope these little nodules are shown to be factories within which are millions of bacteria—good, progressive ones, deserving of award—busily at work. Just here comes in the aid of the chemist, who proves that these millions of bacteria are manufacturing a fertilizer of very great value in the cultivation of sugar cane.

The diffusion battery has entirely superseded the mill and other methods of extraction in the beet-sugar factories, and is being gradually adopted in the cane-sugar house. I shall limit myself to a very simple, homely description of this process, especially intended for those who know nothing of a diffusion battery. Take twelve tin cups and place them in a circle, numbering from No. 1 to No. 12. This we will call the battery and each cup a diffusion cell. Shave up some sugar cane into thin chips and fill the cells with the same. Pour hot water into cell No. 1, and after soaking a while pass the liquid contents to No. 2, etc., up to No. 12. As fast as the liquid contents of No. 1 are passed onward, refill cell No. 1 with hot water until the entire circuit has been made, when an analysis of the liquid contents of each cell shows a percentage of less than 1 per cent of sugar in No. 1, gradually increasing up to about 10 per cent in cell No. 12. This embodies the principles of extraction by diffusion. In practical work the diffusion battery is so constructed that this routine of diffusion is continuously carried on; but to give a detailed description of its construction and use would require the writing of a volume.

Most of the larger sugar factories are under chemical control for the purpose of preventing loss; not for compounding sirups and molasses of doubtful character, which is a separate business carried on by "mixers." The skillful, careful chemist can use poisonous ingredients in making a harmless sirup; but all molasses is not bleached under such conditions. I have previously given a hint upon this subject, and would like to have a long talk about table sirup, but condense my views by simply saying that a pure refined white cane sugar dissolved in boiling water to saturation is the best table sirup known.

The Ottoman Empire, Japan, China, Netherlands, Belgium, Java,

Mexico, Sweden, and other foreign countries at the Exposition exhibited confections, cakes, and other sweets of great excellence and high commercial purity, although, in some very few cases, perhaps the American gustatory nerves would require to be educated a little to fully appreciate their merits. At least, such was the experience of the writer.

While avoiding partyism, there are some facts of political economy in connection with the sugar industry of Louisiana which do not seem to be understood except by those who have been "squeezed through the mill;" hence I make a few statements, at least indirectly, bearing thereon. Sugar planter is not synonymous with wealthy lord or pompous nabob. Anterior to the little unpleasantness between the North and South, thirty years ago, the profits of sugar plantations of Louisiana were largely due to the increase of slaves. If it pleases the reader to call these plantations "human stock yards" let him bear in mind that, with comparatively few exceptions, never was stock so well cared for, whether the motive was humanity or dollars and cents. After the war frequent political agitations kept the sugar industry in an unsettled state till the bounty of three years ago gave the industry a more rational impulse in building it up by improved machinery for manufacture and better methods of cultivation, by the aid of greater chemical skill, and scientific progress especially adapted to the locality. When it once takes root on this basis, the sugar of the United States can compete with foreign sugars, tariff or no tariff, bounty or no bounty, but not now, while the industry may be said to be in a new birth, hanging to life only by a hair of uncertainty through the chaotic wranglings of politicians. Can sugar be made at 3 cents per pound in Louisiana? was asked of 15 sugar planters, 13 of whom replied no, but for the past three years, with sugar about 3 cents, 1¾ to 2 cents bounty, they had made, by careful management and close economy, a fair profit, all of which was spent in improvements in hopes thereby to be enabled to lessen the cost of production. The remaining two planters answered yes, but neglected to state that they had made no improvements, and, although realizing 5 cents per pound for sugar, had annually, for the past three years, given Shylock an increased vendor's lien to stave off a little longer "gone by the board." This little incident speaks for itself more forcibly than any comment I could make. The cultivation of sugar demands a heavy outlay of cash and close attention to the business. The sugar planter is a laborer worthy of his hire, yet is often, proportionately, the poorest paid of anyone on the plantation. The industry in Louisiana is the living of about 500,000 people and adds millions of dollars to the wealth of the United States.

A few days ago I was shown a ground plan and side elevation of a sugar factory intended for Louisiana, of the capacity to work up 1,500

tons of sugar cane daily. The order for it is now pigeonholed awaiting the actions of Congress—that is, will it or will it not destroy the industry in the United States? The cost of such a sugarhouse fully equipped with modern improvements would be about one-half of a million dollars. Let us figure a little. Now, 1,500 tons of cane at 180 pounds of sugar to the ton equals a daily output of 270,000 pounds of sugar, or 16,200,000 pounds for a manufacturing season of sixty days, which at 4 cents per pound gives us $648,000 as the crop for the year, its cultivation and manufacture requiring twelve months. Putting the cost of cultivation and manufacture (not saying anything about land and mules at the present) at 3½ cents per pound, which is less than the average in Louisiana the past season, we find the expenses run up to $567,000. Interest at 5 per cent on $500,000, the cost of factory and machinery, is $25,000. As the $567,000 expenses are paid at intervals, say semimonthly, during the year, I calculate the interest thereon for only six months, making, at 5 per cent, $14,175. Add $567,000 plus $25,000 plus $14,175 and we have $606,175 expenses, which subtracted from $648,000, income of the crop, leaves us $41,825, or 8.365 per cent of the cost of the factory. But even this is not all profit, so let us divide 16,200,000 pounds of sugar by 3,000 and it gives us 5,400, which closely approximates the number of acres in cultivation, which at $6 per acre for rent of land equals $32,400. Good sugar mules cost $200 per head. Eight mules are needed to cultivate 100 acres in sugar cane, hence 432 needed in this case, which multiplied by $200 equals $86,400. Ten per cent on this, and it will not equal the loss by death and wear and tear, is $8,600, to which add $32,400 land rents, and it gives an additional expense of $41,825, leaving a final balance of only $825. There are many little "Shylocks" and "sugar suckers" continually gnawing at the planter's pocket, of which I have made no mention.

The planter can eke out an existence for a few years at 4 cents per pound for his sugar, but it would only be at the expense of his sugarhouse, leading to his individual bankruptcy and the destruction of the industry in the United States. During three years of the United States bounty, the industry has progressed near 75 per cent. Let the planter realize 5 cents per pound for sugar for five years, untrammeled by Congressional agitations, then the industry would have progressed by improved methods to such an extent that 4 cents would not only give the planter a fair living, but insure still greater progress at less price and in greater quantity, making all the sugar needed for consumption by the United States. Would it not add wealth to the United States to have such factories as I have spoken of spring up? Not only in Louisiana, but each State where sugar cane, beet, sorghum, or maple can be raised—and I may add cornstalks, for beautiful sugar can and has been made therefrom. I clamor for sugar in the United States that production may equal consumption. Let foreign nations teach

their people to eat as much sugar per capita as we do in the United States and thus help us, while helping themselves—the most rational course to keep the market up to a living standard.

The Rillieux train was first erected on Myrtlegrove plantation, Louisiana, in 1844. In this invention Mr. Rillieux is justly entitled to be called the father of the multiple effect of 1894. The claim to the introduction of the first vacuum pan in the State rests between Valcour Aimé and Morgan, of Orange Grove, lower coast.

Mr. John Dymond, of Belair plantation, weighed his cane in 1872 as it was brought to the cane shed. In 1873 he bought the cane on the Fanny plantation by the ton from the Citizens' Bank of New Orleans. In this weighing of cane Mr. Dymond laid the corner stone for chemical research and control in the sugarhouse of Louisiana, weight being the foundation of chemical science. This was soon followed by the use of the polariscope, then glucose determinations, and now, in 1894, no first-class sugarhouse is considered complete without its chemist.

The charter of the Louisiana Sugar Exchange, of New Orleans, dates March 6, 1883. The inaugural ceremonies occurred Tuesday, June 3, 1884, the officers being Hon. Edward J. Gay, president; John Dymond, esq., vice-president; D. D. Colcock, esq., secretary.

Merely as a curious item, mention is made that in March, 1894, Collector Carter deposited to the credit of the United States Treasurer $925, being the proceeds of 34,000 pounds of sugar collected in 1-pound samples at the custom-house by the bounty bureau from the crops of 1893–94.

The Louisiana sugar experiment station, Audubon Park, New Orleans, was inaugurated by the sugar planters in 1885. Prof. William C. Stubbs, Ph. D., was elected director, which position he still holds (1894). Through his energy there is now connected with the station a thorough school of agricultural, mechanical, and chemical sugar work, both theoretical and practical. It is doing a good work for the economic production of sugar in all countries.

In 1751 the Jesuits of Hispaniola sent sugar cane, with negroes for its cultivation, to the Jesuits of New Orleans, but the experiment proved unsuccessful. In 1778 families from the Canary Islands settled in the Terre aux Bœufs district, now known as St. Bernard Parish, La. About this time appeared Julien Poydras, whose name is handed down to the present not only because of his connection with sugar, but by reason of acts of great benevolence.

Étienne de Boré was born in the Illinois district of Louisiana in 1740. In 1794 he bought a quantity of sugar cane from Mendez & Solis, and in 1795 made a crop of sugar, 6 miles above New Orleans, which sold for $12,000. To him is unquestionably due the credit of being the first in Louisiana to commercially granulate the cane sirup

into sugar crystals, thus practically establishing the sugar industry in the United States, although for some years previous Mendez & Solis had successfully cultivated the sugar cane, yet succeeded only in making sirup and poor rum therefrom. Tradition and other evidence assert that within 5 miles of Poydras's plantation, Louisiana, cane was successfully raised and made into good sirup as early as 1779, the locality then being known as Terre aux Bœufs. Strong evidence indicates this as the locality of Mendez & Solis, the latter being on record as a settler here anterior to 1779.

The mere writing of this paper is the work of but a few hours, yet weeks have been devoted to it that it might contain reliable facts, statistics, and illustrations of a character to show the vastness and commercial importance of the sugar industry; also to show the progress from its early days up to the date of the World's Columbian Exposition—an exposition which may aptly be called the world's university of all nations, whose educational and progressive influences will stamp themselves upon future generations in the evolution of the human race to a still higher standard of excellence which is now screened only by the mantle of the future.

I copy from the Youth's Companion an excellent article, compiled from the United States Census bulletin for 1890, showing the progress and wealth of the United States of America from 1880 to 1890:

THE NATIONAL WEALTH.

The steady progress of our country and our people in wealth, notwithstanding periods of comparative depression and of general discontent, is brought out clearly in a series of reports derived from the researches of the Eleventh Census, lately published by the Government.

One report presents the true value of all real and personal property in the United States, exclusive of Alaska. From this it appears that the total value in 1890 was $65,000,000,000 against $43,000,000,000 in 1880, an increase of nearly one-half in ten years.

Were all the property evenly divided among all the people, there would have been $1,039 worth for each one in 1890, against $870 worth in 1880. This is an increase of a little less than one-fifth.

Put in another form, the average addition to the value of each person's property in ten years was $169, or nearly $17 a year. Of course we all understand that the property of the country is not distributed evenly, nor have all the people made an increase of wealth during the period of ten years. The census takes note only of aggregate and averages.

We must remember this again when we come to examine the figures which show the average and total wealth of each geographical division of the country. The census can tell us how much all the property in Michigan is worth; but it can not tell what part of its copper mines are owned in New England, or how much of its railroad property is owned in New York.

The geographical division which possesses the greatest body of wealth, real and personal, is that officially called the North Central, which begins with Ohio and extends westward to the foot of the Rocky Mountains. This section possesses more than $25,000,000,000 of total wealth, against $21,000,000,000 for the North Atlantic division, usually called "the East."

In wealth per capita these two geographical divisions are nearly equal. The average in 1890 was for each not far from $1,200.

But the richest section—supposing all the property to be owned by the people residing within it—is the western division, stretching from Wyoming to the Pacific Ocean. It possesses an average wealth of more than $2,000 to each person. The wealth of Nevada equally divided among all its people, would give them about $4,000 each.

On the other hand, the two southern divisions are the poorest of all, having property to the value of less than $600 to a person; and a division of all the property of South Carolina among its people would not yield $350 to each.

This represents a great change since 1860, when the Southern States averaged greater wealth per capita than those of the North and West. Then the Western States, too, averaged poorer than the East, whereas now the reverse is the case.

Another tendency with regard to property is shown in the statistics of the leading manufacturing industries just made public. As a rule, the industries show a great advance in capital employed, wages paid and value of product from 1880 to 1890; a smaller proportion of increase in the number of employees, and in a great many cases a marked decline in the number of establishments engaged.

This seems to show that, while the industries have been growing greater and richer, they have been concentrating in fewer hands.

By far the greatest item in our national wealth is still, as it has always been, real estate—land and the improvements upon it. This item comprises nearly two-thirds of the whole. Of the real estate valuation, just about one-third was for farm lands, including fences and buildings, but not including live stock, farm implements, and machinery.

All these items showed an increase of from one-fifth to nearly one-half in ten years; though in that time the value of farm products increased but little more than one-tenth. The farming business has expanded in a much larger measure than its profits have increased.

In ending this "Talk about Sugar," permit me to state that I have conscientiously endeavored to be accurate in facts and statistics. If the reader has been interested and culled some information about sugar therefrom, I shall be made glad; if not, I fear I shall be tempted to console myself for "love's labor lost" by quoting "Ne Jupiter quidem omnibus placet," which, in plain English I render, Not even Jupiter pleases everyone.

TAPESTRY.

BY

MRS. HENRY STOCKBRIDGE.

TAPESTRY.

By Mrs. Henry Stockbridge.

The term "tapestry" has come to us involved and complicated with a list of industrial imitative arts, which threaten to overthrow its primal signification. For clearness, it is desirable to state that the textile named "tapestry" in this report is distinguished by the method of weaving. It may be composed of threads of wool, linen, cotton, or silk, but tapestry is always a material adorned with figures, which are an integral part of its structure; these figures are artistic and formed by handwork. It is credited with being the earliest of arts, but in ancient times was so joined to embroidery that some confusion has ensued. Embroidery presupposes a foundation on which ornament is applied, tapestry finds its ornamentation in its foundation itself.

Modern explorations in Etruscan pottery show Penelope seated upon her upright loom, with the border of tapestry partly completed. The vase bearing this design was found at Chuisi in 1871, and is reckoned by archæologists to have been made 400 years before our era—about 800 years after the time she is believed to have lived. This would place tapestry among the practiced arts 1200 years before Christ. Penelope said to her lovers then, "Wait till I have woven a pallium for my missing lord which shall picture his great, brave deeds"—for tapestry was not only regal, but historical and biographical in ancient times. Not only his woven name and portrait should be wrapped about his body, but the events in which he shared should serve to ennoble his ashes.

Nations like ours have had no eras told in tapestries, and may undervalue its importance in the past, ignore the ideas and despise the conquests it effected, the changes it wrought in life itself. Its importance in the society of its day demands some notice.

In various lands, among wandering peoples, it formed the ornamentation of tents; among settled nations it served to deck the temples, to brighten festivals, to give the luxury of privacy to houses which boasted no interior divisions save hangings for many ages.

Semper, the German archæologist, says: "Draperies gave the first stimulus to building." Old mosaics show tapestries across the fronts of royal palaces in place of doors.

Lessing believed certain bas-reliefs of Nineveh to have represented tapestries. Hebrews, Assyrians, Chinese, and Persians all cultivated the art. The tabernacle was decorated with it. The "veil" of hyacinth and purple and scarlet linen upon which was represented the mystic cherubim, which Solomon gave to the Temple of Jerusalem, was tapestry. Different colors of the foundation establish it.

After the Jewish captivity, at the entrance of the rebuilt temple, a new "veil" was hung, of "fine linen and scarlet," red tapestry on white ground. This was carried off by Antiochus and given to the temple of Jupiter Olympus. At last a third hanging or "veil" was given by Herod the Great to the Temple, once more rebuilt. This was a marvel of textile art, a great tapestry of Babylon, and in the elaborate designs were arranged symbolic colors. Blue represented air; scarlet, the fire; purple, the sea, and the linen stuff, the earth. This was the veil which was "rent in twain from top to bottom" at the hour marked forever as separating the ancient moral world from the new. It is said to have been of such solidity that two horses could not burst the threads apart.

The ancient looms in which tapestry was wrought differed little from the upright ones used to-day in Asia, where costly rugs and cashmere shawls are woven with inimitable skill. There have been two forms—the upright loom on which the warp is rolled at the top, and the horizontal loom, where it is rolled on a beam level with the end at which the worker begins. In the upright or "haute-lisse" form, the worker's eye is his measure, and his design is often small. In the horizontal or "basse-lisse" loom the design must be the exact size of the completed textile, and it is fastened to the underside of the warp. The weaving in this last loom is "wrong side up," and with a hand mirror the progress is inspected, while the design is pressed close to the warp, for measurement and comparison of shades, very frequently.

There are many modern adjustments in these simply contrived looms, but in this Exposition the display of the working model loom from Japan and the "basse-lisse" from Aubusson have shown agreement in essential points.

Penelope wove, and other queens and princesses have followed her example. When nations became civilized, every woman was a princess in her own home, and the arts of spinning and weaving appertain to her realm. The moment that taste and luxury were diffused, assemblies took place; best garments were "en règle," and the presence of women became a part of these assemblies. This was the first step toward woman's advancement in society. Previous to this her's had been the servile lot—always the inheritance of the feeblest. She freed herself by the invention of arts to which her nature was suited, and the earliest of these arts was tapestry. Her development goes on to-day. The Zuñis have already raised themselves above their tribal friends by their artistic tapestry weavings.

The robes of Chilkat Indians, made from the loose, coarse wool of the Rocky Mountain goat, show considerable talent. Their totem designs, if we were able to read their signification, would add to their dignity. The scheme of color is artistic, but it may be the result of limited knowledge of vegetable dyes rather than choice. The Zuñi Indians have long since taken advantage of commercial opportunities to obtain wools already dyed, even raveling out American flannels for the threads to reweave them in their own work.

The excellent specimens from Alaska shown in this Exposition have been loaned by Mr. Ayers, of Chicago. From Mexico there are instances of aboriginal tapestry work, mostly in borders used to adorn their simple weavings. There is little tapestry of value in the exhibits from Persia, and but one instance from Siam. Bulgaria has excellent examples of commercial interest. In that country the same method of weaving has been practiced with large threads of wool, and rugs are constructed upon immense upright looms at which fifteen or twenty women can work at the same time. Their hangings are Saracenic in design and color. All their work is characteristic—oriental and sincere. It has the form but not the artistic taste which gives rank to tapestries.

According to Pliny, the use of the gold thread in tapestry is accredited to one of the kings of Pergamos who lived eleven centuries before Christ.

Allusions to tapestry abound in the Greek classics. Agamemnon complimented his lovely prisoner slave in exalted terms for her work, "fearing the gods would envy him." Calypso sung while playing the shuttle. The immense stores of tapestry gathered by Alexander the Great would have drained all Greece, and must have been confiscated from Darius. The Parthenon was hung, without and within, with marvels of artistic draperies.

Tapestry came early to Rome; was spread, mainly, by the fostering protection of Christianity. Every great Basilica had gifts of importance, and from its treasury gave orders for great processional pieces and for hangings. The gifts included not only designs from religious events, but any costly work obtainable from the far Orient. Griffins and dragons were hung indiscriminately with Biblical stories. But when officials gave an order the work was limited to the history of the church. It was Constantine, and later on Crusaders, who assisted in introducing the oriental style. The monasteries were schools where tapestry weaving improved, and women were notably the pupils. Undoubtedly Queen Matilda, the wife of William the Conqueror, had assisted in many a pious tapestry before planning the historical embroidery which has kept her memory green. True, the work of hers, we know, is only embroidery, but so important has been the information gained from it of the dress, manners, dates, and actual

life of the eleventh century, the world unanimously ranked it among tapestries to do it honor.

It has been a matter of congratulation that this Exposition should have been able to display so worthy a copy of her famous work—the Bayeux tapestry. It has hung upon the gallery wall of the woman's building, 76 yards in length and one-half yard in height, and is the exact size, color, and stitchery of the original. Thanks are due the French commissioner, through whose kindly influence the loan was effected. Thousands of visitors have studied it with scholarly interest.

A rage for tapestries of enormous size followed early after the art became popular. A part of one prodigious work is still extant. It bears the name of the Apocalypse of Angers; was begun in 1376 and progressed in the family of Louis of Anjou till 1417. King René took it up in 1431 and maintained till 1453. The last piece of it was completed in 1490 by a daughter of Louis XI. This immense work was woven of colored wools on white wool warp. It was divided into seven parts, each 24 yards long and 5 yards high. The artist's name was Hennequin or Jean de Bruges, painter to Charles V. He drew his themes from miniatures in the illuminated missals of the Emperor's library. Full description of its designs will be found in the article of Mon. A. de Verdilhac, Suisse Revue.

In the East were accumulations of immense hangings, which seem incredible. Royalty had its hoards and its artists for designing any great event which might glorify the monarch. Looms and designs were part of royal furnishings, and no artist disdained to be employed in such work.

Renan has said: "Royalty does not suffice to uphold a great movement of spontaneous art. Municipal republics are needed for this." Tapestry might well be quoted in illustration of that opinion.

The commercial air of Flanders proved most favorable to progress in tapestry. Discoveries made in perspective hitherto wanting, enabled the designs to show a depth which they had lacked. The Flemish weavers called for "clearness of grouping, grandeur of drawing, and dramatic feeling." Quality of threads improved, silk and gold were more lavishly used, dyers invented numberless tints, and, finally, the weavers learned to blend their colors with dexterity unknown before. But though the Flemish school showed charming simplicity and truthfulness in delineating nature, they never acquired any renown in historical composition. Often the wives were more skillful, and maintained the fame of their husband's ateliers. The designs, or cartoons, made for the Flemish weavers, remained their property, and they were free to copy them as often as they chose. A well-preserved specimen of Flemish tapestry, woven perhaps near 1575, is found in the German exhibit brought here from Munich. It has been repaired with creditable skill, retaining marks which show that

it was woven in Brussels. The title is "The Philosopher and his boys." The colors are excellently preserved and the grouping of the three persons unrestrained.

Another large and important tapestry, probably from the royal factory at Madrid, is of earlier date. It is stretched across the Moorish pillars of the Spanish exhibit—a lonely relic. Columbus did not gaze upon it in the Convent of La Rabida, for everything in its design and execution betokens its lordly belongings. The border of fruits and leaves is superbly wrought. Wherever it has been repaired, it is the silk, not the wool, which lost strength. Its great merit lies in design and excellent balance of color.

FRENCH TAPESTRY.

France has made the name of Gobelin familiar in every land. With generous hand, since 1662, when the place was bought by Colbert for the Crown, study and artistic genius have there wrought hand in hand with industry. The Gobelins have seldom been appreciated in other countries. Their designs have been criticised and colors have been studied, which have laid broad foundations in all the departments of textiles. The skill required for the dying of tapestry threads has spread into departments of printing in cottons and linens and silks throughout France.

If the antiquarians have wished to limit the work of the Gobelin and Beauvais establishments to lines as narrow as the old Flemish tapestries they adore, and to dictate a standard of excellence which was most admirable in the fifteenth and sixteenth centuries, France has been fortunate, indeed, to have evaded such influences and to have had a supervision and control which has regarded the work of these institutions, not as specimens for millionaire collectors but as themes of study and experiment for her actual working classes. The Gobelins are maintained for the French people. It should be as it is—her glory to be nothing but her own national art, making progress and change as the artist and manufactures of the country progress.

In the work of the Gobelin looms merino wool is used exclusively. By singeing the threads the surface becomes like velvet, the quality of the wool produces a purity of tone, a depth and tenderness richer than painting and more durable than any other form of decoration in colors.

Four magnificent panels of Gobelin tapestry were sent over by the French Government to adorn our Fair, all of recent production. One of the two largest bore the attractive title La Filleule des Fees, after the design of M. Mazerolle. The size of this tapestry is 13⅛ feet in height by 24¼ feet in length. It was commenced March 10, 1879, and finished February 3, 1888. The number of artists in tapestry engaged upon this piece, whose names are given in the catalogue of

the French Government, are six. This does not include names of those whose apprenticeship in the school has been of sufficient duration to entitle them to the privilege of assisting in the less complicated parts, nor those who have been skillful enough to have assisted in dying the colors required; these are all master artists and teachers. The composition of the scene is what its title indicates, a charming baby or "god-child," which the fairies, having adopted, are protecting from harm. The naughty witch in the foreground, who is being driven into her shell parachute; her steed, a wise old owl, wings widespread for flight, is one of the best and most picturesque of the many figures in the composition.

The panel corresponding in size with the first-named, and which is entitled, "Arts, Science, and Letters in Antiquity," was designed by M. Ehrman. Commenced November 21, 1880, finished February 15, 1888. It bears the names of five masters or professors of the art of tapestry. Its central figure, blind, poorly clad, harp in hand, does not seem to receive any attention from his better-dressed companions, who perhaps think Fame flying in the air is coming to do them honor instead of grand old Homer; but the spectator makes no such mistake, and gives entire sympathy to the lowly, unconscious poet. The dignity and repose of this design is admirable, as well as the color.

Some idea of the patience and skill required may be formed from the fact that a skillful workman has accomplished a full days' work when he has completed 1 square inch of this tapestry, while the slighest mistake in color or adjustment of threads often wastes months of labor.

We have not undertaken to supply any technical explanation of the modern system of uniting the texture where change of color takes place, because illustration conveys more than words in such matters.

There has never been so superb a pallette of colors as that maintained by the Gobelins. They claim to discriminate about 14,000 shades. Their modern finish of the wool employed in these panels owes its perfect smoothness to careful singeing of the thread.

The other two examples of Gobelin work, entitled "Manuscript" and "Printing," are upright panels, each portraying a life-sized standing figure. Both panels and their borders were designed by M. Ehrman.

"Manuscript," a woman clad in yellow drapery, is singularly fortunate in color and in grace; while "Printing," being a man, wears an air of strength and conscious pride in that strength. Together, the difference is conspicuous, notwithstanding the uncertain character of their draperies. One turns from one to the other, puzzled to discover the changes wrought without lines or shadows.

Beauvais tapestry is constructed mainly of silk at the present time. Formerly it was of wool, with great attenuation of threads. Designs

for it are of a different order, smaller in size, and held in lines of purely decorative thought.

Eight panels, of which those by Gaudefroy are most interesting, are mingled with the display of Gobelins. The subjects of Gaudefroy's panels are "Birds of the Aviary" and "Aquatic Birds."

Two sets of furniture in the same department are covered with Beauvais silk tapestry of exquisite taste and refinement. The designs are garlands of flowers, one on a foundation of pink with white in the central space of the garlands; the second, a tender lovely green. The constant acclamatory admiration bestowed upon these exhibits constrain us to confess our poor sentences can not even enumerate the words of unanimous approval from every class of visitors. M. Chabal was the designer of both sets of floral covers.

The Aubusson tapestries are exhibited by ten private firms, and some of their pieces come almost to the point of rivaling the Gobelin and Beauvais tapestries.

The firm of Braquenie & Co., of Paris, among many others, exhibits a panel of great merit, depicting the "Stairway of the Paris Grand Opera House." Another of their tapestries in which the accord of mellow colors is unusually successful is "Europa and the Bull."

G. R. Hamot, of Paris and Aubusson, exhibits a fine tapestry entitled "Blind Man's Buff." It is a garden scene with pleasing groups of children and adults, full of life, and of excellent color. A collective exhibit of real tapestries embrace these two names in addition to others, whose work is of average merit.

JAPANESE TAPESTRY.

Old examples of Japanese tapestry have, like the Chinese weavings, both warp and weft of silk. The difference of warp (silk being much finer than wool) necessitates more threads to the square inch. In really fine instances the increase of threads in the warp will be often three times that required when wool is used. In work of the present day cotton warps are frequently found, but not in valuable examples. There is a large wall hanging, by Sozayemon Nishimura, in the Manufactures building, which exhibits more clearly in design than any other the distinct national character of Japanese tapestry. The gnarled tree trunks and mossy stones are there in gravest somber tones, dear to the Japanese heart, and also a majestic waterfall. The true poetic expression of former days is there. It is a tapestry of sentiment. No one can judge it fairly who only values color, or harmony, or decoration. But this is old Japan.

Another fine hanging by Sasaki, of Kyoto, in complete contrast with the first, may be appropriately called "Matsuri, by the Inland Sea." It is a rare new Japan, revealing itself without a trace of foreign influence. The ground of gold and silk, the color of the metal, is

enlivened by clouds extending far away among the many shadowy islands, dark in contrast with this sunset glow. In the foreground are wagons decked for the festival (matsuri), with gayly painted processional groups of figures, each wagon bearing aloft in the center a high bamboo pole or young growing tree. The design, though simple, is superb, and the treatment artistic in the highest degree. Few such pieces are in the whole world.

The same might be said of the great tapestry of J. Kawashima, of Kyoto, which bears the title "Procession at the Nikko Temple." Its size is 22 feet by 13 feet. Besides the grand gate of the Yomei Mon, and the trunks of the enormous *Cryptemeria* trees which form the distance, are the library and other buildings of the famous Quadrangle. From the gateway surges the crowd of pilgrims, soldiers, citizens, and dignitaries—586 figures of men in all the variety of costume which enriches the festivals of the Tokugawas. It has been wrought with immense attention to every detail. The faces all differ in expression. Some of the figures are barefooted and others with costly sandals. Their garments are literal copies of real clothes. It is said a single face is the result of from three to ten days' labor, and the workmen, who numbered several hundred, were occupied four years in making this remarkable hanging. This tapestry is wrought in threads of gold and silver, as well as silk. In Europe the use of metallic threads has been objected to mainly from the ungainly stiffness which was apparent as it depended from the rod. But the art of Japan has discovered a more flexible metallic thread, or the attenuation of their gold to match the fineness of the silk has led to more successful results.

Another superiority is shown in quality of metal. The alloys of gold in other countries soon tarnish and become an imperfection which can not be removed. That is not true of Japanese alloys, as I can testify from experience. Even the alloys of silver do not tarnish from the gas fumes as readily as our own manufactures in the pure metal.

It would be a proud trophy for Japan to secure this record of her hero's era to hang in one of the Iyeyasu temples, still thronged by loyal crowds.

The list of Japanese triumphs in tapestry would not be complete without recording the signal merit of a library hanging or curtain by Jida Shiahichi. I shall name it "My Basket of Flowers." It is a piece peculiarly suited in form, design, and color for adoption in an American residence. There is a freedom in the plan of it, and a lucky accident of color which obtains for it a first choice from everybody. The large veined lotos leaves tumble down between the pink lotos flowers and chrysanthemums, till one almost expects them to rest on the white jonquils below. One long crooked wisteria stem with scant pale bloom reaches over the upper line of the curtain, like the black sheep of the family, which will show its nose at the banquet. Below the ecru satin

ground is a border of brown, sewn with butterflies and fishes in gold. There are many hangings of great merit among the Japanese tapestries which we have not mentioned. This must be accepted as noting the lines or divisions of the numerous artistic efforts indigenous in that oriental land. They have been quick to discern the merits, and to avail themselves of improvements in the technique of tapestry, and it is safe to predict for them a series of victories in all lands in this art industry.

TAPESTRY OF GREAT BRITAIN.

The English nation is represented in tapestry at our Exposition by the work of only one establishment—The Royal Windsor Tapestries.

It is a matter of regret that the mother of so many sturdy peoples should permit her early accomplishments to decline in this era of bright promise for art and industry.

Once upon a time, tapestry ateliers were widely scattered through England, and examples of English work are yet found in her colonies as well as in her halls and museums. Believing in the greater merit of French and Flemish work, they imported their tapestries so liberally as to utterly destroy their own national establishments. It is recorded that one ship, in the days of Henry VIII, carried 4,000 tapestries to England.

After the French and German war, in 1871, many idle tapestry workers sought employment on the hospitable English shore. From this gathering of skilled artisans came the organization of the Royal Windsor tapestry establishment. The family of Queen Victoria exerted their influence to make it popular and useful, but the limited demand for such costly work and the absence of any subsidy for part of its annual expenses finally required its discontinuance. The aim of the management was to combine the broad effects of arras, or old Flemish work, with the detail and elaboration of Gobelin. In this it has met with changing success.

One hundred and fourteen examples were brought here, but there was not space for them all to be displayed. Those which were hung had space on the walls of the sculpture courts of Great Britain in the fine arts building. The single figures of historic character were of great merit. "Richard Cœur de Leon" and "Savonarola," by H. Bone, were especially noticeable for weaving effects rarely seen in such sized panels.

The three panels mounted in a screen, "Jean d'Arc," Cimabue, and Vittoria Colonna were admirable in spite of their heavy modern mounting. Also by H. Bone.

The landscape hangings, representing a stag hunt and a boar hunt, each 9 by 11 feet, designed by E. M. Ward, were vigorous in expression and splendid pieces of tapestry. All of the landscape series are thoroughly English in conception and execution; quiet and even som-

ber in color, and in marked contrast to the work which the French refugees must have practiced when in their ateliers at home.

It is a matter for regret that there could not have been a tapestry hall where these works would have been better viewed and more generally understood.

NORWAY TAPESTRY.

I wish it were in my power to communicate to the rest of the world the surprise and delight of finding that there was a philanthropic society in Christiana, and that it had a soul of its own—or else Mrs. Freda Hansen has one for it, which amounts to the same thing. Under her inspiration, perhaps, it has accomplished some astonishing tapestry. It has come down with reindeers and pine cones, and dancing bluebells, which last turn out to be little Norse flower fairies, holding hands to sing songs of Odin to the 'prentice boys. And like everything else in this building, it has no wrong side.

There is an Egyptian epic poem, called a piece of tapestry, told in the Norse dialect, with Tanhauser swans sailing over silver waters, where the rough waves are all kept underneath the surface of things, and a border of mummies holds the lotos plants in order. I wish they had brought a hundred such gems and sold them as quick as they have these unique exhibits of characteristic original Norwegian art. We who have bought them should be the happier for it.

ANTIQUE TAPESTRY.

EXHIBIT OF SYPHER & CO., OF NEW YORK.

From a collection of antique tapestries shown by Mr. Sypher, which contains specimens of great value, the following titles are given; not because of the great names of their designers, nor because kings and cardinals have interested themselves in their manufacture and ownership, but from their dignity, character, and perfect preservation. To the student, desirous of marking the change and progress in Gobelin work, this has been a fortunate season. Those who have boasted the superiority of Flemish designs and colors have here the satisfaction of seeing them ranged side by side.

1. Naval battle between Constantine and Lucinius. Designed by a pupil of Guilio Romano, and woven by Jacques de la Riviere (of wide renown) in the Barberini palace about the middle of the seventeenth century.

2. Queen Artemisia, attending the practice in horsemanship of her young son. Designed by Lerambert, and woven for Marie de Medici in the Gobelin ateliers in the early part of the seventeenth century, and presented to Cardinal Barberini by Louis XIII.

3. Diana. Painted by Breuil, woven by Antoine Goubel, of Brussels.

in the seventeenth century, for Cardinal Barberini, one of a series of seven illustrating the life of Diana of Poitiers. The Flemish taste is here shown in its best coloring. The soft, delicate green of the leaves, and the background of architectural gardening are in splendid preservation.

4. Constantine superintending the construction of Constantinople. Cartoon painted by Rubens; tapestry woven in the Gobelins. Presented to Cardinal Barberini by Louis XIII.

5. Judith and Holofernes. Woven in Brussels in the seventeenth century for Cardinal Barberini, by H. Rydams. The border of this piece, more elaborate than the others, shows a panel over the great central group containing this inscription: "Holofernum Astote et speciosam victoriam promittit." It is given here simply as an instance of one of the many ways devised to distinguish original work from copies even at that early day. These hangings were inventoried by Cardinal Barberini in 1695. They are each about 24 feet in length and from 13 to 18 in height. Their perfect condition is testimony to the great durability and unchangeableness of tapestry, and their noble lines of color make deep impression on students in decorative art. Their titles and artists have been specially mentioned as testimony of their presence in this Exposition. By such mention in catalogues the history of many valuable pieces has been perfected.

IMITATION TAPESTRY.

The origin of this recent fancy, which has almost threatened us with a revival of mediæval designs and colors, is very curious. Many valuable pieces of antique tapestry decayed in spots too large to attempt remounting and reweaving them. An ingenious Frenchman gave inspiration to the manufacture of corded or striated linen corresponding to the coarseness of the indentations in the real tapestry. This linen was subjected to some bleaching or chemical treatment which prepared it to absorb water readily like half-worn linen. It was then stretched over a frame, the broken tapestry securely fastened to it, and the missing parts were drawn in corresponding design and brushed with weak liquid dyes to stain the linen without obscuring its surface. It was necessary to let it dry before adding a second coat, but it soon became an easy matter to match the faded tints so perfectly the patch was scarcely seen.

The next step was to make an entire copy from fragments too poor for any patching, and the new art work was installed. It has a field of usefulness to which it should be confined. How much it has contributed to the decoration of this Exposition in covering the interior walls with copies of well-known artistic work, both of famous tapestries and paintings, every attentive visitor already knows. The ceiling

work of artistic furnishings, the side panels of tapestried apartments, and a dozen other uses where it served every purpose that the original could have done, prove it an economical substitute for places where decoration is imperative but of transient necessity.

In France the copies made with care have great intrinsic merit. "After the Gobelin"—well, it is some distance after; but on another accurate copy when we read, "First medal in Paris Exposition of '89," we begin to draw the line.

The copies of the great Barberini tapestries from Italy, which grace the sculpture halls in the Fine Arts Building, are worthy because they are authentic substitutes. It is probable that more and more governments will send substitutes to foreign lands to represent historical, and, of course, priceless work. But do not let this decorative linen be daubed with thin oil paint, which stiffens where it should be pliable, and which fills the crenulated linen, hiding its structural meaning, and obscures the blunders of an ignorant first treatment with liquid dyes. The linen is not in sympathy with picture painting. A knowledge of the consequences of applying one dye upon another can more easily be learned in a dye shop, and more cheaply, too, than on a tapestry-linen design.

In Germany there is excellent imitative work, judging from the serviceable panels of her important booths.

In Denmark is one so carefully done as almost to deceive the eyes, the irregular "points" or hatchings being dragged into prominence after the coloring was completed. Much of this work done in the United States is unworthy, through ignorance of its sincere aim. The State fairs need it; the various associations would adopt it if limited to supply hangings capable of being rolled and carried without harm.

It might in time be a valuable aid to a general knowledge of tapestry and its interesting history and gain a permanent footing among modern industrial arts.

A few scattered instances of tapestry may be found in the Eastern exhibits.

A silk tapestry in Turkey of unsurpassed quality, but of questionable merit in design, even allowing for conflicting influences, must be mentioned. This is neither Saracenic nor even Turkish, but shows a possible future for something greater than either.

The exhibit of Bulgaria, although mainly in rugs of tapestry weaving, rather than hangings, shows indication of taste, which if fostered may be most serviceable to its people. Their natural aptitude for loom work, their picturesque choice of costumes and colors, form favorable surroundings, needs only some such fostering care as has already been started by the Norwegian Government.

In the East Indies and Ceylon are instances of small tapestry work, but mostly overlaid with some hand stitchery, which has deteriorated

its value. In all the eastern lands there is little or no discrimination between the individual work of the shuttle and the needle. Whenever the result of the first has been incomplete its deficiencies have been covered with the last. Like the early European work, the joining of colors has been mostly by needle stitches.

It is marvelous that where the perfections of the great camel's-hair shawl productions are and have been the wonder and pride of a continent it should not have made more impress in kindred lines of work.

TAXIDERMY.

BY

Dr. R. W. SHUFELDT.

1463

TAXIDERMY.

By Dr. R. W. SHUFELDT.

There were two very distinct classes of exhibits submitted to me for adjudication. One class was a miscellaneous collection of objects from Sydney, New South Wales, Australia, and were on exhibit in the Woman's Building; the other class consisted, in the main, of mounted collections of animals from Brazil, New York, Pennsylvania, and other States and Territories. The last were all to be found on exhibition in the Anthropological Building.

The part of the New South Wales collection examined by me was chiefly made up of certain objects placed on exhibition by private residents of the city of Sydney. It consisted principally of some drawings by school children, paintings on opal and on glass; a case of mounted mammals and birds from that part of Australia; a small, though beautiful, collection of cattle represented in miniature models in wax, with the hair on; feather work and embroidery, and a number of similar objects. For the majority of these I recommended that an award should be given, and as those that received such distinction will no doubt appear in detail in their proper place in the published history of the Exposition, I omit that part of the record here. It will be as well for me to state, however, that there were frequently various circumstances that influenced me in deciding in the matter of an award in many of these cases, and I am quite sure other judges often found themselves in similar predicaments. Sometimes the object exhibited was but slightly above the average in point of merit for its kind, while it possessed the advantage of being quite unique. Take for example the eight or ten models of cows in wax which were favorably adjudicated by me. They were but a few inches in height, but were modeled with great fidelity to nature, and the natural hair that covered them had been dexterously applied, so as to give one the impression of its being a genuine growth. Here was a unique collection that received an award; but the case might have been otherwise had there been on exhibition a large collection of animals prepared in a similar manner and of varying merit and presented by various exhibitors. Take again, as another example, the large pencil drawings placed upon exhibition by the school children. Judging them purely upon their merits they received awards. Not only were these unique

in their place, but they were also remarkable pieces of work when we come to consider that they were done by children. From this standpoint they were judged, and much in the same way as though they had been submitted to an examiner at a competitive school examination where such pieces of work were presented, rather than by placing them in comparison with all the other pencil drawings that were upon exhibition at the Exposition. Had the latter test been applied, they would in all probability have been passed by almost unnoticed. Circumstances under which any particular exhibit was produced or manufactured constituted often another series of factors that a judge was in duty bound to take into consideration; sex was another, and race still another; and there are many more, which it will not be my purpose to touch upon here.

Passing to the taxidermical exhibits of mammals and birds, and other vertebrata examined by me in the anthropological building, we at once enter upon an important field that requires some considerable notice. Of recent years taxidermy has played a very essential part in practical science, and it is improving in that particular every year as biologists and public instructors connected with scientific institutions of learning of all grades come to recognize more and more its value. In many quarters it has made remarkable progress, producing work of very superior merit from whatever point of view we may judge it.

It no longer, as it formerly did, suffices the purpose, even in the best museums, to have the mounted specimens of mammals, birds, and other animals simply "stuffed" and in all sorts of grotesque and unnatural attitudes, set up in badly lighted cases, upon all kinds of unsuitable stands. Where scientific taxidermy has made its best advances the days for work of that kind have gone by. A scientific taxidermist of the present time borrows from many of the sister arts and sciences what he needs to crown his own endeavors with the most perfect success. In nature he closely studies the habits, the attitudes, the peculiarities of every living form, as he does everything that makes up their natural surroundings, as the associations of various plant growths; the nature of the ground, as well as the varied forms assumed by water, as snow and ice; pond effects; rills and waterfalls, and the rest All this, and much more, he must reproduce in the cases in the museum, and that with a fidelity to nature quite outside the pale of criticism. The scientific taxidermist also borrows the science of the chemist, the art of the colorist, the accomplishments of the photographer, for photographs of living animals and their natural haunts stand among his best and most reliable models. To a great extent, too, he must be a good general biologist, and a close student of all that has been written in that science which in any way may prove of service to him in his work. The chemist teaches him how to use certain preparations that will preserve his specimens so as to have them best withstand the

ravages of time and the insidious attacks of hosts of many kinds of insect museum pests. The artist teaches him to select those colors which best reproduce nature's own tints, and which will best withstand the action of light for great lengths of time without impairment or fading. And in addition to all this, the scientific taxidermist should be possessed of an innate culture and refinement of his own, which admits of a constant improvement through the education that nature brings to every student so organized who applies himself with all due earnestness to the study of her works.

For nearly twenty years past, at different times, the writer has observed with great satisfaction the growth of the taxidermic art in no less a celebrated institution than the United States National Museum. There it has passed through every phase of its modern growth, from the lowest stages of crudeness to the higher planes of perfection, so far as the latter has been carried. It has been my fortune to have seen some of the best pieces of some of the most talented taxidermic artists in this country, and they have been closely studied. Doubt no longer exists in the premises. We know what taxidermy has accomplished in recent years, and the standard she will attain to before many more have gone by. As I have said in another connection, the time is now at hand when our best equipped public museums should seriously apply themselves to the task of placing on exhibition, in appropriate cases, entire sections of country with every topographical detail reproduced with the strictest fidelity to nature. Such reproductions should not only show the variations of different geographical areas in our own country, but the various faunæ and floræ they support. In large museums such exhibits can be so arranged as to gradually merge into each other, and the student may be enabled to pass from lifelike and graphic representations of one part of the country to various others in natural series. They should show the animals of all classes inhabiting them and their habits, the botanical characteristics, the various races of men and their principal employments, the geological structure and many other features. Such exhibitions would very soon act as a powerful stimulant to education in those directions, and by combining much that is now divided up into a number of departments, would in the end more economically fulfill one of the chief functions of any museum—i. e., increase its usefulness as an institution of public education.

In the various collections in the Government building at the Columbian Exposition, there was much exhibited that showed the general tendency in this direction. It was seen in some of the superb specimens of taxidermy sent on by the Smithsonian Institution and the United States National Museum, as well as their magnificent models of examples of the various races of men, and similar subjects. Some of the scenic effects in the "General Greely group," showed pretty well what

we may hope for in the future in the way of exhibiting arctic and other scenes. Combine some of the work to which I have just made reference, and the ideas I have advanced above would very soon commence to take on a proper shape.

In the taxidermical exhibits submitted to me for examination there was scarcely a hint of the great progress made in modern taxidermy. The collection sent on by the Empire of Brazil presented not a single feature to recommend it, while to point out its objectionable ones would take more time and space here than can in any way be afforded, as absolutely nothing would be gained in the performance of such a thankless task. The State of Pennsylvania had sent on a great spectacular affair, representing the side of a mountain, with trees and shrubbery and a stream of running water (real) coursing its way through a valley at its foot. Distributed over the sides of this mountain, on the trees and plants, and in many other places, were 279 mounted specimens of birds, 32 mammals, a few reptiles, etc., while around the rail that inclosed it was a cotton-filled box-like receptacle, in which was displayed a collection of some 127 eggs of the more common species of birds of the State. The idea which this great set piece embodied is, to some extent, the correct one. It was an attempt to exhibit in their natural haunts the animals of a certain political division of a country, or a State's zoology; but such educational value as it possessed, or even scientific interest, was entirely lost in the manner of its execution, for the taxidermical part of the work was about as bad as bad could be.

Something of a similar nature, and on nearly as large a scale, had been attempted by the State of Maine. In this instance it was composed almost entirely of mammals, while the taxidermy and accessories were both quite as indifferent as were those features of the Pennsylvania exhibit. It was clearly out of the question to recommend an award for a piece of work so far behind what is now considered standard by the modern experts of that science. After my decision in this case had been received I was honored with a communication from Secretary Horatio N. Rust, in which I was asked to reconsider my judgment, inasmuch as "it seemed proper, since the State furnished good material, but was unfortunate in being unable here (Chicago) to secure a good taxidermist." From this point of view, but still very much against my better judgment, I recommended an award on the ground of the State having succeeded in placing on exhibition such a large number of animals representing her mammalian fauna. Practically such an award was worthless, as I intended it should be, in the event of the collection ever being broken up into parts, and the single pieces ever being judged, perhaps by experts, upon taxidermical grounds.

A private collection from Colorado, which also fell to my lot, requires

no formal notice here, beyond what I have already written upon my examination card.

One of the best exhibits of this kind, I believe, that I examined was one from New York. It was recommended an award. It not only represented many of the existing mammals of the State, but a number of those now extinct there. Some few of the mounted pieces were very good as examples of taxidermical work, and there were other evidences of the collection having been carefully prepared and placed on exhibition. One of its interesting features was a fine mounted skeleton of a mastodon (*Mastodon giganteus*), presented by Alfred Wild, esq., for the Harmony Mills Company, of New York. This exhibit completed my labors.

TOBACCO.

BY

JOSEPH B. MOOS.

1871

TOBACCO.

By JOSEPH B. MOOS.

The great tobacco industry, which now yields to our Government an annual income of $32,000,000, had special cause to contribute its choicest products to add to the general splendor of the commemoration of the four hundredth anniversary of the discovery of America by Columbus.

The introduction of tobacco into civilization can be traced to the discovery of America, and it can, therefore, truthfully be asserted that the World's Fair of 1893 commemorated, in a measure, the birth of tobacco.

Tobacco now constitutes one of the world's greatest sources of wealth. Before the blue smoke arising from its combustion issues from between the lips of the smoker, its cultivation, manufacture, and distribution have furnished a subsistence to millions of men in every country on the globe. Those who delight in making such calculations inform us that there are 800,000,000 human beings who sweeten life's journey by indulgence in the habit of smoking tobacco. Then, again, these statisticians tell us that the human race consumes annually 2,000,000 tons of tobacco, being about 70 ounces per capita.

Consumption of tobacco in all its forms by the people of the United States, taking as a basis the data collected by the Internal-Revenue Department, is about 4 pounds per capita. From other sources we find that in the United Kingdom it is $1\frac{5}{16}$ pounds; in France, $1\frac{1}{8}$ pounds; Germany and Holland, $3\frac{1}{2}$ pounds. The consumption of tobacco in the United States is, therefore, greater per capita than in nearly all other countries, with the exception of Germany. In this country, therefore, especially, the cultivation and manufacture of tobacco has become such a leading source of wealth, the Government having derived an income in the last thirty years of $908,266,457 in internal-revenue taxes from this source, that it is not inappropriate, in reporting on the condition of the manufactured-tobacco interests as shown at the Exposition to devote a little space to tracing the details of the history of this article of commerce.

After a careful examination of the existing literature on the subject the unbiased investigator must arrive at the conclusion that the true history of tobacco dates back to the dim and unknown traditions of the early American races.

Among the remains of the former habitations of the Mound Builders, which are so plentifully scattered through the Mississippi Valley. numerous pipes have been found. A paper issued by the Smithsonian Institution, entitled "Ancient monuments of the Mississippi Valley," contains the following passage:

> Mound builders were inveterate smokers, if the great number of pipes discovered in the mounds be admitted as evidence of the fact.

Whether or not the material smoked in these pipes was tobacco has not been positively established. In support of the theory of its having been a species of tobacco, the claim is put forward that when America was discovered its inhabitants were smoking tobacco, and also the absence of evidence that any other article was ever put to a similar use by the aborigines of this continent.

Whatever conclusion we may arrive at as to the time when the first inhabitants of this continent discovered the use of tobacco, we can hardly find a vestige of actual proof that anything closely resembling tobacco was used by the peoples of the other parts of the globe before its introduction into Europe by the Spanish and English mariners.

It is unquestionably true that there has been much circumstantial evidence collected by men anxious to show that the uses of tobacco and its cultivation were known to the Orientals before the discovery of America, and that before the discovery of the New World it was found in the Ardennes.

Meyen informs us that the consumption of tobacco in China is enormous and the custom of great antiquity. On very old sculptures he has observed tobacco pipes of the form still in use in Persia. Legend is quoted to the effect that Shirez tobacco was given by a holy man to a virtuous youth, disconsolate at the loss of a loving wife. "Go to thy wife's tomb," said the anchorite, "and there thou wilt find a weed. Pluck it, place it in a reed, and inhale the smoke as you put fire on it. This will be to you wife and mother, father and brother," continued the holy man in Homeric strain, "and above all, will be a wise counsellor, and shall be to thy soul wisdom, and thy spirit joy."

The Mohammedan legend on the subject is too long for repetition under its eastern garb; suffice it that a viper was restored to health by the warmth of the prophet's body. Immediately upon convalescence the ungrateful reptile announced the intention of biting his preserver, and the prophet expostulated. An argument ensued which ended in the viper carrying out his original intention. The prophet drew the venom from his wounded wrist and spat it forth. From these drops sprang that wondrous weed, which has the bitterness of the serpent's tooth conquered by the sweet saliva of the prophet.

In reply to the assertions of Meyen, as well as his quotations from folklore, and the mass of assertions made by Savary, Ulloa, and others, in their attempt to prove tobacco as unknown to the ancients, it can

truly be said that had the use of tobacco possessed the high antiquity in these Asiatic countries which it had in America, the record of ancient travelers would give us some clew to its existence. The habit of smoking could certainly not have escaped their notice.

The use of tobacco has never been introduced without rapidly spreading, and the habit can scarcely be acquired without being continued. These travelers, although they speak of betel chewing, palm wine, arak, sago, etc., never even hint at the existence of tobacco; and it is natural to assume that they did not describe tobacco simply because there was none to describe. It is, of course, in evidence that some of the earliest nations were fond of intoxicating fumes; that it was common to indulge in whiffs of narcotics. These facts are made known to us by Herodotus, Pomponius, Plutarch, and others in their accounts of the Babylonians, Thracians, and Massagetæs. From the descriptions given of the plants which, when smoldering, gave forth the intoxicating fumes which so pleased the peoples of these nations, it can be asserted that they could not possibly be tobacco. The descendants of these races in Persia, Syria, Egypt, India, and Arabia at present smoke hemp, and it is possible that the substance which their ancestors threw upon the burning coals was hemp or a similar product.

Hippocrates recommends the smoke of burning herbs as a medicinal prescription. Pliny speaks of its inhalation through a reed, but nowhere do we find in any of these writings indications of any knowledge of tobacco. We will, therefore, dismiss all these vague surmises and proceed on the hypothesis that tobacco is a native of America so far as actual history shows.

Two sailors who were sent out by Columbus to explore Cuba, in the latter part of the year 1492, were probably the first Europeans who ever saw a tobacco leaf. In reporting their adventures to their chief they stated that they had met savages who carried with them lighted fire brands and puffed smoke from their mouths and noses. Upon investigation Columbus found that these savages were smoking dried leaves from a plant which grew on the island, and which they rolled up in the tender shucks of the Indian corn. Fra Romano Pane, who accompanied Columbus on his second voyage in 1494, and who remained in charge of Haiti, wrote Peter Martyr that the natives ground the leaves of this tobacco plant into a powder, which they breathed into their noses through a reed or cane.

In 1525, Hernandes de Oveido, then viceroy of San Domingo, wrote an intelligent description of the plant, which he had brought with him and was cultivating as an ornamental plant in Spain. A few years later Francesco Hernandes, a Spanish physician who had been commissioned by Phillip II to visit Mexico, brought with him upon his return a number of the plants, which he presented to his King, and

about the same time missionaries returning from the southern portion of North America and the West Indies brought with them tobacco plants and seeds.

For many years after the Spaniards had gained a foothold in America they looked upon the use of tobacco among the Indians with abhorrence. In an old history written by Francis Lopez de Gomara, it is stated that this abhorrence continued until it transpired that a Spaniard, accompanied by an Indian, went on a long journey, and almost starved owing to the scarcity of food. The Indian finally persuaded him to smoke tobacco, which formed a taste which others of the soldiers and sailors soon cultivated.

In 1559, Jean Nicot, a member of the French court, returning from Portugal, where he had filled the post of ambassador, presented his queen with some tabacco plants which he had purchased in Lisbon. In compliment to the queen the courtiers called the plant Herbe Medicee.

There are a few authorities who contest Nicot's claim of having introduced tobacco into France in behalf of Thevet.

Innumerable attempts were made in those days to saddle some new name upon the plant, especially the names of those who helped to introduce it. They have all remained, however, in the dust of old books, leaving the original appellation, given it by Hernandez, who had heard the term used by the Indians. Some claim that the name is derived from the island of Tobago, one of the West Indies, but it is doubtful whether the island received its name from the fact that the leaf was found growing there, or whether the leaf received its name from having been found growing on the island. The scientists during the seventeenth and early part of the eighteenth centuries, called the plant Nicotiana, in honor of Nicot. This name has come down to us merely as a term for its essential oil, nicotine.

A fact which seems to have been overlooked by many is that the seeds which were purchased in Lisbon by Jean Nicot, who was then the French ambassador there, had just been brought over from Florida, and not from the West Indies. And here it will not be amiss to state that as early as 1573, according to old Spanish records, there were numerous extensive fields of tobacco in the country north of the inland sea, called by the Indians Okeechobee, in that section of Florida known as Cacena, and one hundred years later tobacco was one of the staple crops of the Kissimee Valley in Florida.

From this time forward, the medical qualities of the plant caused its introduction all over Europe. The Spanish doctor and botanist, Nicholas Menardes, published a book in 1571 at Seville, descriptive of the West Indies, in which he describes tobacco as a medical plant.

There is evidence that tobacco was brought into Italy almost simultaneously by Bishop Nicholas Tornabone from France and the Cardi-

nal Santa Croce from Lisbon, where he had been Papal Nuncio at the Spanish court.

The Englishmen were probably the first Europeans who learned to use tobacco for smoking purposes; that is, in a pipe, as it was several centuries before cigars were used. Sir John Hawkins was the first to bring tobacco to the notice of Englishmen in 1565. Shortly thereafter Sir Francis Drake brought samples of the plant into England.

We read in Lobel's Stirpium Adversaries Nova that tobacco was successfully cultivated in England and Scotland in the year of its publication, viz, 1571. In 1586, Ralph Lane, who had been sent out by Sir Walter Raleigh as governor of Virginia, returned to England and brought with him some tobacco plants and several Indians, who illustrated their method of using the plant. This fact was afterward attested to by King James. In this way Sir Walter Raleigh and Ralph Lane were probably the first Europeans of influence and high standing in the community to set the example of smoking tobacco.

It has been stated by some that Sir Walter Raleigh, after having learned the fashion of smoking, was especially anxious to diffuse the custom as a means of introducing a profitable article of merchandise from his new American speculations. If this was his intention, he was eminently successful.

Mr. Bancroft informs us that in 1615 the fields, the gardens, the public square, and even the streets of Jamestown were planted with tobacco, and it became not only a staple but the currency of Virginia. From this time forward there can be no doubt that the English took the lead in adopting the use of tobacco for smoking. Those writers who claim that smoking was introduced into France and Spain twenty-six years previous evidently confound the introduction of the plant into France for medicinal purposes with the practice of smoking in England.

A Frenchman, Charles Estienne, probably deserves the distinction of having been the first to give an account of the tobacco plant in 1564. His short and inaccurate description was amplified and corrected by John Liebault in the following year. In France it is certain that tobacco as a luxury was first and for a long time used in the shape of snuff alone, and even thus it did not become in vogue before the reign of Louis XIV. It was scarcely before the great Revolution that the French became general smokers, although they had been all along inveterate snuff takers.

It is, however, evident from the works on tobacco written in the latter part of the sixteenth and seventeenth centuries that the first use of tobacco when it was introduced into Europe, as above described, was exclusively for medicinal purposes. Jean Nicot sent it to Queen Catharine de Medici simply as a remedy for toothache, and church and state countenanced its introduction for its supposed sanitary virtues,

while physicians seem to have looked upon the plant as a divine remedy for disease.

In fact, tobacco crept into Europe under false colors. There were water infusions of it for draughts, oils of tobacco for imbrocations, and sirups of tobacco. Applied hot to the body, the leaves were an infallible remedy for paralysis, rheumatism, and the bites of serpents and insects. Incorporated with grease and ointments, it was a sure cure for all skin diseases.

From this excessive praise it was but natural that the reaction should follow. The first book against its use appeared in 1602, entitled "Work for Chimney Sweepers." In 1604 came the famous "Counterblaste to Tobacco" written by King James I., in which the monarch expressed a disapproval of smoking in such strong terms: "A custom loathsome to the eye, hateful to the nose, harmful to the brain, and in the black stinking fume thereof nearest resembling the horrid stygian smoke of the pit that is bottomless." In 1614 Star Chamber imposed a tax on tobacco.

All this proved of no avail. While the wise men were either praising it on account of its supposed medicinal qualities or condemning it as a work of His Satanic Majesty, its use was quickly filtering downward to the great masses of the common people. In England it was called "drinking tobacco."

We read that in 1614 there were upward of 7,000 tobacco shops in London, and they were set up in almost every lane and corner. In fact, thirty years after its introduction into England smoking was more general than even at the present day.

The first tobacco plant was brought into Germany out of France by Adolph Occo, the city physician of Augsburg, in the early part of the seventeenth century. In 1622 the English and Dutch troops camping on the banks of the Rhine brought the smoking habit with them, and the Thirty years' war spread it throughout the balance of Germany. In 1636 Spanish priests introduced snuffing into Rome. In 1650 tobacco smoking was commenced in Sweden, Russia, and Turkey. Asiatic people were completely conquered by the weed. Every man, woman, and child took to smoking.

All this astonishing growth and use of tobacco took place in the face of the fiercest opposition by those in authority. Church and State combined to persecute the smokers. They were delivered over to scourgers, knives, gibbets, and death in all the countries of Europe. In Russia the noses of smokers were cut off. In Turkey the offenders were punished by having their pipes thrust through their noses. Pope Urban VIII thundered excommunication upon all souls who took the accursed thing in any shape into a church. In 1653 the council of the Canton of Appenzel, in Switzerland, summoned smokers before them for punishment, and ordered all innkeepers to inform against those who were

found smoking in their houses. In the police regulations of Berne, in 1661, the prohibition against smoking stood with the commandment against adultery. It is a fact that up to 1848 smoking was forbidden on the streets in many of the countries of Europe.

MANUFACTURE.

The first form of manufactured tobacco in all these countries was simply the drying and rubbing of leaves, to be placed in the bowl of a pipe. We also learn from the earliest records of the use of powdered tobacco for snuff taking. In the record of the House of Lords we find a petition, dated 1641, by a merchant of London, who claims redress because three years previously he had shipped a cargo of "sneezing tobacco" to Dublin in the *Thomas and George*, the vessel whose master was forbidden to land by the authorities of that city, on the ground that certain individuals there had a patent of the sole sale of tobacco.

The idea of cigars, which was first suggested by the Indians' crude method of wrapping the leaves in dry shucks, did not seem to meet with much approval on the part of the Europeans for many years after the use of tobacco became common. Although tobacco must have been freely smoked in Spain from the beginning of the sixteenth century, there is no evidence of the use of cigars among the Spanards of that time. In the multidinous works of the great Spanish artist Goya, of that date, there are none of his characters depicted as smoking cigars. In Zedler's Universal Lexicon, published in Germany in 1740, there are a number of pages devoted to "nicotiana," but not a word spoken of anything akin to our cigar. There is a paragraph stating that it is reported that some of the inhabitants of the West Indies take the leaves of tobacco and twist them into a shape resembling a cornucopia, so that they are open at one end and tight at the other. They light the open end and pull the smoke toward them as long as the leaves glow and they can keep them in their mouths. In this way, the writer says, they spare the use of a pipe. The first cigars made by the Spaniards were of tobacco loosely rolled and held together by a silky lining of corn husk, with a straw running through the center, to be withdrawn before smoking, to insure a good draft.

The word "cigar" seems to have originated from the fact that when the Spaniards first used them they were smoked in the orchid, called in their tongue "cigarrals," owing to its being the abiding place of those sleep-producing insects, the balm crickets; hence we have "cigarro," a cigar; "cigarron," a large cigar; and, finally, the English "cigar." Actual cigar smoking was introduced into London by a young Spanish grandee in the year 1787.

In 1792 a cigar-manufacturing plant was established in Cuba by the firm of Cabanas & Carvajal. The product of this factory was shipped

to various countries of America and Europe, and the factory is still in existence, and conducted at present by L. Carvajal & Co.

There is no authentic record of the introduction of cigars into the United States. "Segars" were classified in the second act of Congress. In 1790 they were admitted free of duty, and continued free until the act of March, 1804, when they were taxed $2 per thousand. It is claimed that Herr Schlottman introduced cigars in Hamburg, Germany, in 1788, after serving in Spain. The first actual record of cigar manufacture in this country dates to 1819, to a Mr. Gibson, who manufactured them in Maysville, Ky. Another early manufacturer was F. Bodman, in Cincinnati, in 1827.

From this time, then, dates the commencement of the cigar-making industry in this country. There seems to have been very little progress at first. Imported cigars could be brought into the country so cheap that there was no incentive to establish manufactories here. There was no great change in the crude and simple state of the trade up to the time of the breaking out of the war. The use of tobacco by the soldiers of the war, on both sides, gave an immense impetus to the trade, and instant improvement in its manufacture took place.

One of the first important changes in the art of cigar manufacturing was the introduction of the cigar molds. These originated in Germany, and were first imported into this country in the year 1869, although they did not come into use until some time in the following year. As near as can be ascertained, these first molds were used by Jacoby & Co. and Kerbes & Speiss. Shortly thereafter N. H. Borgfeldt, recognizing what an important factor molds would prove in the cigar-making business, began making what are termed single molds, namely, one mold in a block. Immediately a great demand arose for these molds, and he was always pressed for orders. Manufacturers brought him cash and vied with each other in inducing him to sell them these crude molds, for which they paid $1 a piece. The introduction of these molds to a great extent revolutionized the business, as it enabled manufacturers to turn out a cheap cigar which had all the appearance of the higher-priced article made by hand. The system of making cigars by mold has been, of course, vastly improved upon since its inception in the manner described. The theory remains the same, viz, the making of the interior filling, or bunch, of a cigar by laying the filler tobacco together in a heavy leaf, or binder, and pressing it in a wooden mold to give it shape, which could not otherwise be done but by the deft fingers of an expert cigar maker. The smoking qualities of a cigar thus made are naturally inferior to one strictly made by hand, but its general appearance is such that only those trained in the business are likely to detect it.

The introduction of machinery into the manufacture of cigars in this country can be traced to the efforts of one man.

John R. Williams was born in New York City February 13, 1841. At the age of 15 he commenced work at a shoemaker's bench. During the war he served in the ranks, and after its close in the revenue service. He finally started a cigar factory in Newark, N. J. After becoming acquainted with the business he early recognized the possibilities of introducing machinery into this field. He also maintained that the twisting and rolling of tobacco into cigars was work more adapted for women than men, but had considerable difficulty in teaching women to prepare the bunches for the molds. He began experiments with the idea of producing a machine by which these bunches could be made by the most unskilled operators. On February 1, 1875, he completed his first real cigar-bunch making machine. It was found to work fairly well, and after extensive improvements and alterations were made the perfected machine was set up in the factory at Newark and the cigar-manufacturing trade invited to examine it. As is usually the case when radical innovations are suggested, it took considerable time for the trade to fully realize the advantages of the machine. Williams, having been successful with the bunch-making machine, turned his attention to solving the problem of wrapping machines, and evolved the well-known automatic rolling table and wrapper cutter. Then came his long-filler device. In all twenty-three patents have been granted to Williams for devices for bunch making, wrapper cutting, and rolling. There have, of course, been many other machines invented and placed on the market, but we have spoken of those manufactured by Williams because he was the acknowledged originator of the idea.

Another noteworthy innovation in cigar manufacture was the introduction of Sumatra tobacco, which first came into general use in this country in 1881. Its rich, glossy leaf pleased the fancy of the consumer, and therefore the retailer, while its thinness and great number of leaves to the pound, combined with its then reasonable price, made it popular with the manufacturers. As a result, in a very short time nearly all domestic cigars costing over $20 a thousand were covered with the Sumatra leaf. This acted detrimentally on the sale of American grown wrapper tobacco, and the efforts of the American growers have therefore been directed toward inducing the Government to so heavily tax this tobacco that it should be driven out of the market. In this they have been but partially successful, for although the duty has been placed at a higher figure than its original cost, yet this foreign leaf has become so popular with American smokers that they prefer an inferior cigar covered with this leaf to one of a better grade with an American wrapper.

The great and rapid increase of cigar manufacture in this country since the year 1860 caused a corresponding growth in the production of cigar boxes. The internal-revenue laws prescribe that all cigars

must be packed in boxes of designated capacity. Before the act of 1862 many of the cheap cigars made in Connecticut and other parts of the country were handled in bulk and not packed in boxes, and where boxes were used they were refilled many times. Immediately after the passage of that act it became a penal offense to sell cigars which had not been properly packed in boxes, and the use of the box was forbidden after its original contents had been disposed of.

These regulations, which have been in force ever since 1862, have resulted in the cigar-box industry becoming a business of important dimensions. About 65 per cent of all cigars manufactured to-day are packed in boxes containing 50 cigars, the balance in boxes containing 100 or 225, and a few containing 250. It takes between 60,000,000 and 70,000,000 boxes annually to pack the cigar production of the United States. A great majority of these boxes are made of white wood veneered or otherwise manipulated to imitate cedar boxes. The better class of cigars, however, are packed in boxes made of Spanish cedar, which is imported in logs from Cuba, Mexico, and other parts of Central America. The average cost of the cedar box, including labels and other trimmings, is about 9 or 10 cents; if made of white wood, about 7 cents. The lumber is transformed into boxes almost entirely by machinery. One factory, located in New York City, which is the largest of its kind in the world, produces annually nearly 6,000,000 boxes.

The labeling of cigar boxes assumes many elaborate styles. The finest and most expensive productions of the lithographic art are at present demanded for this purpose. Another important adjunct to the modern cigar package is the ribbon, which encircles the goods packed in bundles. Until 1872 every ribbon used on cigars in this country was imported. Then the rapidly increasing demand encouraged experiments to produce them in the United States. These attempts proved successful, and now the large cigar manufacturing plant of the William Wicke Company, in New York City, weaves every day 200,000 yards of these ribbons.

The first attempt at cigarette manufacturing in this country was made in New York in 1867 in a very small way by the Bedrossian Brothers. The cigarette business did not attract much attention in the trade and its development was very slow until about 1880. The established tobacco manufacturers took up the business as a sort of side issue. After that time the use of machinery and keen competition resulted in giving a great impetus to the business, the bulk of which was thrown into the hands of a few large houses, who have ever since practically enjoyed a monopoly. The struggle of these leading houses for supremacy became very fierce, enormous advertising through the public resulting in an ever-increasing production of cigarettes, and their consumption increased enormously from year to year. When,

however, the expense in forcing the sales had passed legitimate bounds, the leading houses came together and formed the great combination which now practically controls the business. The present production of cigarettes annually in the United States is a little over 3,000,000,000.

Although a leading tobacco manufacturing firm of the present time was established as early as 1760, these first attempts at manufacturing tobacco were confined largely to snuff making. European methods were copied and a creditable article produced. The preparation of smoking and chewing tobacco was then very simple. The leaf was used almost in its natural state, following closely the methods in use by farmers and planters in preparing the leaf for home consumption.

The first tobacco manufactured for chewing purposes in this country was made in twist shape. After that followed the plug tobacco, and finally, during the present century, fine-cut chewing tobacco came into vogue.

About 1824 a manufacturer by the name of Patterson turned out the first sweetened plug from his factory at Baltimore. For a number of years he kept his methods secret and did a prosperous business. One day, however, a sailor in cutting off a piece from a plug detected a lump of licorice, and from that day forward the method of sweetening plug tobacco became generally known, and in fact was demanded by the public taste.

About 1830 appeared the first fine-cut chewing tobacco. It was an unsweetened chew, made of Virginia tobacco. It came rapidly into popular favor, especially in the East, where it could be procured fresh from the factories. The principal difficulty was that after it became dry its taste became acrid and disagreeable. To remedy this, sweetening and flavoring substances were added. Within the last thirty years the sales of fine cut have steadily decreased, until now they are but about one-quarter of the amount that they were immediately after its introduction.

The drop in the sales of fine cut was caused, to a great extent, by the increase in the popularity of plug tobacco. This was most especially the case after the grade of tobacco known as White Burley became generally employed in the manufacture of plug tobacco. There are two claimants to the honor of discovering this grade of tobacco. One is Mr. Joseph Foos, of Brown County, Ohio, who noticed some plants come up almost milky white on a farm near Higginsport. He first thought they were damaged, but after noticing how vigorously they grew he changed his opinion. After they were cured a fine bright texture caused him to save the seed. The other claimant was named Webb, who, in 1864, procured some Little Burley seed at Louisville, Ky., and as the plants grew he noticed some white ones. He separated and watched them, and finally decided, after several years' experiments, that they were a distinct class and of a very meri-

torious nature. About the year 1870 this White Burley tobacco became generally known to the planters of Ohio and Kentucky, and shortly thereafter entirely superseded Virginia in the manufacture of plug tobacco.

In early days tobacco manufacturing was simply a trade. Now science and modern invention have raised it to a high rank. Originally a tobacco factory resembled a barn. The equipment was crude, manual labor was utilized in almost every detail, the surroundings and arrangements being slovenly and uninviting. The action of nature was depended on entirely to bring the leaf into condition. The manufacturing season did not begin until midsummer, because then the tobacco drank in the humidity and became soft and pliable. A machine resembling a printer's proof press was used for pressing and molding tobacco into blocks. As soon as the frost came the manufacturing season closed.

In a modern equipped factory, and there are but few others—for it is a fact that there are no small plug manufactories, for everything must be done on a colossal scale—the machinery is expensive, and without steam power, heating and sweating apparatus, air ducts and fans for the regulation of atmospheric conditions, it is at present impossible to manufacture plug tobacco. The tobacco arrives at the factory in large hogsheads or barrels. It is tied up in bundles called "hands." It is in a very dry or brittle condition and must be moistened by being exposed to steam, after which it becomes soft and can be handled without breaking into small pieces. The stems are then removed in the stripping room, and from there it is conveyed to dip tubs, where it is submerged in a solution of licorice and other flavoring materials. When thoroughly saturated, the leaves are spread upon a rack and these are taken to the drying room. It is then again softened and conveyed to machines and pressed into lumps. These lumps are then covered by operatives with pieces of selected leaf. It is then again placed in presses to be pressed and finished. After this the lumps are artificially dried by steam, placed in steel molds, and subjected to a pressure of 275 tons. After leaving these machines it is packed into the wooden boxes, Government stamp affixed, and is then ready for the market.

For the year ending December 31, 1892, there were manufactured in the United States, according to internal-revenue returns, 171,081,575 pounds of plug tobacco and 16,222,689 pounds of fine-cut chewing tobacco. Of this amount, about 102,347,302 pounds were leaf tobacco. The balance, about 40,000,000 pounds, was other materials, showing distinctly to what extent flavoring and sweetening is at present demanded by the public.

As a consequence of the civil war in the United States, the internal-revenue taxes on cigars, with the complicated regulations appertaining thereto, were first imposed. In order to raise money to carry on the

war, all prominent tax-producing methods of other countries were copied after. The manufacture of tobacco is one of the first industries in all countries to be subjected to taxation, and, as a consequence, the the act of July 1, 1862, was passed. It imposed a tax of $1.50 per thousand on cigars valued at not over $5 per thousand; $2 per thousand on cigars valued between $5 and $10 per thousand; $2.50 per thousand on cigars valued between $10 and $20 per thousand; $3.50 per thousand on cigars valued at or over $20 per thousand. Following that came the acts of June 30, 1864, March 3, 1865, July 13, 1866, March 2, 1867, July 20, 1868, March 3, 1875, and March 3, 1883, which last is still in force.

In addition to these acts, which appertain both to cigars, cigarettes, and tobacco, there were passed four other acts which affected only smoking and chewing tobaccos—those of March 3, 1863, June 6, 1872, March 1, 1879, and October 1, 1890. Despite this, the internal-revenue taxes on tobacco in the United States are smaller than those imposed by any other country which seeks to make this commodity a leading source of revenue. In the year 1892 these taxes amounted, per capita, as follows: United States, $0.49; United Kingdom, $1.30; France, $1.71; Austria, $1.31; Germany, $1.30; Italy, $0.94; Hungary, $0.79.

The phenomenal growth of the cigar and tobacco manufacturing industry in the United States can in nowise be more forcibly demonstrated than by the accompanying table, compiled from the internal-revenue statistics, which show a fact not recorded in the appended table, that the number of manufacturers of cigars in the United States was 21,337; manufacturers of tobacco, 1,021.

Fiscal year ending June 30—	Cigars.	Cigarettes.	Tobacco and snuff.
	Number.	*Number.*	*Pounds.*
1863	199,288,284	.....	23,852,387
1864	492,780,700	.....	64,577,097
1865	693,230,989	19,770,110	37,641,822
1866	347,443,894	230,365	37,493,785
1867	483,806,456	.....	47,631,494
1868	590,335,052	.....	46,764,150
1869	991,535,934	1,751,495	64,305,026
1870	1,139,470,774	13,881,417	90,288,082
1871	1,313,913,604	18,930,753	95,135,504
1872	1,507,014,922	20,691,050	95,209,319
1873	1,779,946,596	27,088,050	114,789,208
1874	1,857,979,298	28,718,200	107,747,691
1875	1,926,661,780	41,297,883	119,435,874
1876	1,928,807,396	77,420,586	110,380,602
1877	1,800,009,256	149,069,257	116,146,103
1878	1,905,063,743	165,189,594	108,824,843
1879	2,019,246,764	238,276,817	120,398,458
1880	2,367,803,248	408,708,366	136,275,834
1881	2,682,620,797	567,396,983	147,013,405
1882	3,040,975,395	554,544,186	161,324,601
1883	3,227,888,992	640,021,653	170,361,558
1884	3,455,619,017	908,090,723	174,196,064
1885	3,358,972,633	1,058,749,238	180,777,413
1886	3,510,898,488	1,310,961,350	191,592,240
1887	3,788,305,443	1,584,505,200	206,499,521
1888	3,844,726,650	1,862,726,100	209,362,602
1889	3,867,385,640	2,151,515,360	221,524,869
1890	4,067,889,983	2,233,254,680	238,290,158
1891	4,474,892,767	2,684,538,760	253,896,042
1892	4,548,799,417	2,892,982,840	265,126,372
Total	67,133,313,912	19,660,310,016	3,956,862,124

According to a Census bulletin issued by Carroll D. Wright, Commissioner of Labor, under date of April 6, 1894, it appears that the number of manufacturers of cigars and cigarettes reporting were 10,956; that they represented a total capital of $59,517,827; that they employed 98,156 operatives, to whom was paid a total wage of $44,767,989; that the value of their combined product was $129,693,275. Three hundred and ninety-five manufacturers of chewing, smoking, and snuff tobaccos reported a capital of $30,841,316, 31,267 operatives, with a total wage of $8,568,071, value of total product being $65,843,587.

TRANSPORTATION.

1487

VESSELS, BOATS, MARINE, LAKE, AND RIVER TRANSPORTATION, NAVAL WARFARE, ETC.

By Capt. V. M. Concas.

Scarcely anything of superior class or conspicuous importance can be found in the exhibits shown. This is due, perhaps, to the great difficulty and expense of the transportation by sea or land of the very bulky and heavy objects which constitute those exhibits, the high tariffs, and the necessity of carrying back all the exhibits at the same expense. Very few of them are proper to be sold, and these are limited to the most prominent exhibits and can be disposed of only to those directly interested in the traffic of the country, as, for instance, the navigation company, which are all represented in the Fair. Among the shipbuilding trades we miss many of the important firms of the world. No exhibits have come from the important shipbuilding firms of France, whose designs are very popular among the officers of the line of the American Navy; only one from Italy; none from the new shipbuilding yards of private firms of Spain, and very few from other nations; but what can scarcely be understood is how the most important private yard of the United States, the Cramps, of Philadelphia, with enormous contracts with the Federal Government, are not represented, when a display at the Exposition has been very justly considered a patriotic engagement of every American citizen. The ocean navigation companies, under the patronage offered them by the growing prosperity of the United States and Canada, have come with a model of their steamers. One of them, the International Navigation Company, has a reproduction in full size of the half section of one of their steamers, from the water line to the hurricane deck. The greatest number of ships' models belong to the navigation companies, who exhibit them as owners of proper instruments to fulfill their engagements toward the public. Under such circumstances, the models have been considered from two different standpoints. If exhibited by the builders they have been considered as products of their industry in all their details; if exhibited by the owners, they have been judged according to their ability to fulfill the condition of speed, comfort, and safety that the company offers the public.

Though the exhibits of the shipbuilders are less important in the

World's Fair than those of the navigation companies, I shall begin by the former, because nothing is so important as the ship itself in the final point of all naval industries, and the beginning of any maritime trade.

It is without question that England bears the lead in shipbuilding industries, and that the good workmanship, price, and seagoing condition of the ships produced by her yards can not be better. Important exhibits are offered by the shipbuilding firms of Donny & Bros., Fairfield, Hawthorn, Laird Bros., the Thames Iron Works, J. & G. Thompson, and Yarrow. Among the men-of-war models, with the exception of the *Ramilies* and the *Opal*, all the ships have been already at sea for some years and are very well-known types. The most of them have been a success when new, and they have not been superseded by new types in the wild race that naval architects have imposed upon themselves until perhaps a great disaster tells them they have gone too far, and tells also to the officers of the line that they have conceded too much. And the reminder of a great disaster is present, because the best of all models in large size is that of the battle ship *Victoria*, built by Armstrong, Mitchell & Co., of New Castle, upon which hangs the broad black crape of mourning, in sorrowful memory of the sad accident in which were lost the great ship and so many human lives. The public pass through with marked respect, impressed by the consideration of the untold sufferings of those who perished by the most horrible death that can be imagined; but for the seaman and the statesman that mourning goes so far as to be one of the most important events for some countries. The battle ship *Victoria* has been lost on account of a natural accident, as a collision is always very possible in maneuver, and very probable in naval warfare. There should be no blame for their commander; no blame for the gallant admiral who lost his life. An error may be a misfortune, but never is a dishonor. The collision was a natural accident, as was that between the German ships *König Wilhelm* and *Grosser Kurfürst*, in which one of them was lost; but the wreck was quite different, as the German ironclad was sunk in her upright position, and the *Victoria* capsized. The *Victoria* turned her bottom up, her screws racing furiously in the air; and such circumstance was foretold many years ago by the eminent naval architect, M. Reco, for all the ships of that class. The same man who foretold the tremendous disaster of the *Captain*, of Cobs, has foretold how this ship would be lost in case of collision, and yet to-day that class of ships constitute the nerve of many navies, who have invested in them so many millions as to equal the fortune of one generation.

To be sure, a report will be given the proper authority, placing the fault upon some forgotten provision, to restore confidence in similar ships; but the reason they may give nobody will believe, and time will

determine how far will go, at sea and in all the navy departments of the world, the deep mourning we see to-day on the model of the *Victoria.*

I have had the misfortune to be judge for the said vessel; but as the designs were of the English admiralty, and the exhibitors were the builders, I had only to judge of workmanship, which was certainly very good, as I have seen myself on board the same ship.

The merchant shipbuilding furnished something new in the exhibits of the Fairfield and Thompson companies. The former, although voluntarily withdrawn from competition, her director, Professor Elgar, being a member of the jury, exhibits the model of the great steamers *Campania* and *Lucania*, which is also exhibited by the Cunard Line as owners of both ships. The *Campania* is the successor to the *Great Eastern*, with the difference that the latter was produced when the traffic and the passenger necessities were not prepared for her; and the *Campania* and her sister *Lucania* are come to do their service when enormous size, tremendous speed, great spaces for engines, boilers, coal, cargo, and passengers are a necessity of the increasing trade, being to-day the success among the greyhounds of the North Atlantic.

The Thomson's Company, of Glasgow, builders of the *City of Paris* and *City of New York*, exhibit a new model of a steamship that they will name America, and claim will make 30 miles an hour. She appears to be of great dimensions, but could not be judged for want of information. The draft of water appears to be very great, but the necessity of limiting that dimension, on account of the dry docks and harbor capabilities, is the great obstacle to increasing the actual speed.

Let us now consider the exhibition made by the shipbuiding yards of the United States, showing a decided movement, as if they wished that the American mercantile marine should conquer again the high position it had thirty years ago. But though the industrial development is very remarkable, the very low freights on one side and the high wages that the American sailors must be paid on the other makes the success very doubtful. These circumstances are very well characterized in the exhibition, where the yards show that they have many orders from the Government or from the International Company, which is very near thes ame; but the display of the mercantile marine does not show the same proportion.

We have said that the Cramps, of Philadelphia, have neglected what seemed to be a place of honor for any American, while the Union Iron Works, of San Francisco, have exhibited a magnificent model of their works, with the model of the United States men-of-war *Monterey*, *San Francisco*, and *Charleston.* The Newport News Shipbuilding Company, the Chicago Shipbuilding Company, and some others have also made very important exhibits, showing that modern naval con-

struction of every description is under great development and progress in the United States.

Without entering into certain considerations, perhaps more proper to a technical study, I must remark that the modern construction of war ships in the United States retains the high pee board, continuing the famous American constructions of former dates. Their cruisers are different from those of other nations; many of them have a full sailing gear; they have large spaces where living is made a great deal more comfortable than in the European cruisers of the same displacement; and though other qualities are not so conspicuous, it is difficult to ascertain which is perfectly right.

In addition to the construction of great seagoing ships, the United States and Canada have a very large and important display by builders of coasters, tugs, cutters, boats, and yachts of every possible description, and good workmanship, and very reasonable prices as a natural consequence of the competition.

The great number of the craft exhibited and the wonderful variety of design for inland waters as well as for the blue sea prove that there is a great taste and disposition for sea in all the American people. Fishing is more popular than hunting is in any other nation, and the pleasure boats and yachts exhibited by the United States constructors are no doubt the foremost of all.

The gasoline launches are one of the features of the Exhibition, though they have not had the development that was expected when they were produced. But the more special features of the Exhibition are the electric launches, 50 in number, that swarm in the lagoons. The hulks of these electric launches have been made by Thomas Kane & Co. and the Detroit Boat Works, the designs and all the electric gear being supplied by the Electric Launch and Navigation Company, of New York. These launches work with accumulators on ebonite made in London by the Electric and Storage Power Company, the motor and usual dynamo and the propeller having only two blades, and though working on very well-known principles the start made by the company is very important and will bring electric launches to a practical use when the defects that always appear in what is new are corrected. An important lot of those launches have been sold to be used at Venice, and most probably will be used everywhere where stoppage may not involve serious risk and when the passenger may pay for that comfort. A general use makes necessary a large charging station, where will be found economy compared with the wages of engineers and firemen to be paid on the usual steam launches.

Very important are also the exhibits of Orlando & Brothers, of Leghorn, Italy; Bloss & Voss, the Germania Schiff and Maschinenbau, the Settiner Maschinenbau (Germany), the Rio de Janeiro Navy-Yard, the St. Petersburg Iron Works, the Japanese Navy-Yard of Yokosuka;

and though these are only a part of the navy-yards of the world, they show the great development of naval construction in every nation. The models exhibited are all of very superior workmanship and very similar in design, with great analogy to the original designs of the French naval architects. The Italian ships are excepted, whose designs, more like the English, are well known in the maritime world. The products of these navy-yards are excellent, and except in price are not excelled by others in good qualities and good workmanship of their vessels.

We shall finish the report upon the private and Government navy-yards with the observation that we only make reference to those present in the Exhibition, and not to all that exist in the world, as this report is limited simply to that which is exhibited at the World's Fair.

If the ship-building exhibits are important by the great industry they represent, the exhibition of the owners of ships are not less important because of the great capital employed, the great enterprise shown, and the struggle for superiority in each special feature of the greatest competition that ever existed.

As the most important of the ships built in private yards I must begin with the United States Government. It exhibits the most magnificent and original model that has ever been made of a large modern ship; that is, the model of the battle ship *Illinois*, made on a brick foundation in a foot of water in the exact dimensions of the same ship taken from the water line up, which idea has been done only once before in the last naval exhibition of London with the copy of the historic line of battle ship *Victory*. The model of the *Illinois* gives a very exact idea of what that ironclad is, and besides it affords an opportunity for those not familiar with ships to judge by comparison the actual dimensions of any ships the model of which may be on exhibition. Only one fault can be found in the reproduction of the *Illinois*, and it is that while modern ships are overcharged and overcrowded with everything, the *Illinois* appears so free and so spacious that it has room enough to be a small palace of exhibition, of which circumstance the public is not aware, and may believe that the life of the seamen on board is a great deal more comfortable than it is in reality. The most important of all the exhibitions on board the *Illinois* is the very good collection of models of all the new ships of the modern American Navy, whose rapid and important development can be seen in that very nice display. Then follows the exhibition of the Naval School of Annapolis that produces such a distinguished body of learned officers. There is also the very good exhibition of the Hydrographic Department, in which are very conspicuous the pilot charts of the North Atlantic, original and scientific publications sent by that office throughout the world, and with the greatest dispatch, to the United States consuls, to be given free to all navigators. That important

publication is worthy of the greatest gratitude and respect from every seaman in the world. I have the pleasure to contribute mine with profound admiration for that humanitarian service.

Next follows the great navigation companies, who exhibit in the ships they possess a most magnificent display of the enormous resources of transportation for passengers and merchandise across the Atlantic.

Beginning with the American company, the International Navigation Company, which exhibits the models of the great liners *City of Paris* and *City of New York*. That company is now building a whole fleet at Philadelphia with a subvention from the American Government, and exhibits in natural dimensions a half section of one of her new steamers, with cabin, smoking and dining rooms, steerage for emigrants, decks and bridges, which, like the *Illinois*, are excellent reproductions, giving an accurate idea of the ships the same as the ship itself, and helping the public to appreciate the exact dimensions of the other models.

Very important is the exhibition of the White Star Line, with models of her fleet, and one suite of cabins in natural size, but the exhibits of the Cunard and Peninsular and Oriental companies, though not more important, are more original. The Cunard Company exhibits a good model of each set of ships that the company has built from 1840, beginning with the *Britannia*, a wooden paddle steamer, to the *Campania*, the last ship, and the best success in fast steamers. The model of that ship is duplicated in the Exhibition, one model being exhibited by the constructors, a product of their industry, and the other model, quite equal to the former, is exhibited by the Cunard Company as an appropriated instrument to fulfill their engagements to the public, which circumstance is in pursuance of the policy adopted by the committee in making a distinction in the exhibits according to the exhibitor, in one case the builder, in the other the owner.

The Peninsular and Oriental Company exhibits a very curious display of very small models of ships, 2 or 3 inches in length, but in which exhibit are all the ships that have been owned by the company; and the number of ships is so considerable that it impresses the public most favorably in behalf of the great progress and importance of the Peninsular and Oriental Navigation Company.

Very important also is the exhibit of the Spanish Transatlantic Company, with its extended service to the West Indies, Philippine Islands, England, New York, Africa, and the Mediterranean; also the Hamburg-American Packet Company and the North German Lloyd, which lines compete with the oldest English and French lines with fast steamers of the best reputation. Very good also is the Union Steamship Company and the Canadian Pacific Railway, with the splendid steamers that cross the Pacific to China and Japan from the western coast of America. All of these ships are so good that it scarcely could be determined which of them could be called in justice the best.

And though not in competition, at their own request, as were all the exhibits of France, I can not omit the French Compagnie Générale Transatlantique, with the models of the steamers, one of them the splendid liner *La Touraine*, which by its splendid regulations, great comfort and special behavior, and very good seamanship has made that line the favorite of the most distinguished passengers of the North Atlantic. The exhibition of this powerful company with its fast trans-Atlantic vessels, by the extent of capital employed in them, the great skill, intelligence, and industry displayed in construction, the enormous movement of cargo and passengers involved in their continuous runs from one harbor to another, and growing dimensions, make one of the most complete and impressive displays in the exhibition, which facilities are perhaps the safety valve of the excess of production that menaces communities at the end of the nineteenth century.

After having considered both the shipbuilding and the trans-Atlantic service in full I shall refer to particular exhibits, many of them very important, for it is by the perfection of details possessed by modern ships that it is possible for man to command these enormous bodies in spite of an enraged ocean.

Worthy of especial mention is the model in full size of the 120-ton hammer of the Bethlehem Iron Company, which reaches nearly the top of the Transportation Building. The model of that powerful instrument for heavy forgings, used alike for machine work as well as for ordnance, is close to some of their splendid forgings exhibited. There is a 62-ton gun made at the navy-yard at Washington with the tube and jacket made by the Bethlehem Iron Company. That the gun was accepted by the Government is the best proof that the materials are of superior quality. It is true that they must employ Swedish iron made with charcoal, and can not compete in price with Krupp, Creuzot, and other more advanced factories of Europe; but from the American point of view its price must not be considered. This exhibit shows enormous progress to the level of the more advanced manufacturers.

Very important as a mechanical display in their application to different purposes is the exhibition of windlasses, capstans, and similar appliances. All the exhibits are American, with the exception of one ship-steering engine of German production. It is a very important invention, where the high price of manual labor, as in the United States, requires the substitution of so much mechanical labor. But the exhibitors in no other part of the group gave the trouble that some of these have to the committee of judges, as they made every possible exertion not to have their exhibits judged by foreign judges, sometimes even passing the limits of conventionality; but that could not be allowed, as the jury had decided that nobody could be a juror for the exhibits of his own nation. There was no reason for that want of confidence in their exhibits, as they were very good and complete; and though we missed

some self-steering engines for big ships of high speed, they had no competition; and as what is exhibited only must be considered, because if it were otherwise it would become more profitable and less risk to those that do not come, if they were considered on equal footing, I must repeat that the exhibit is very complete, and that the naval architects can find there almost anything to suit all their purposes for ships' use.

Not very numerous, but very good, were the exhibitions of steel, iron, hemp, and manila ropes exhibited by different companies. There were also some chains, but very few kinds, and some anchors of new device, though all with movable posts. One of these anchors has been accepted by the American Navy in some of the new ships. It seems to be much better than the usual Martin anchor, though made on the same principles. Of anchors for pleasure boats there was a greater selection, and some folding ones of very good designs and finished with great delicacy that would be also very useful for steamers.

Asking room for something new were several North American and English exhibitors of steel barges, seamless boats of the same metal, rafts, and life-saving appliances, that can be kept out of the water without danger of leaking, as are those made of wood. Some of the boats were provided with air tanks in each end to obviate the danger of sinking. The public has not yet come to a decision in this matter, perhaps because of the difficulty of repairing or the fear of heavy blows against wharves or ship side ladders; but they would be very useful for boats on the decks of trans-Atlantic steamers, which sometimes are never taken from their davits, and when wanted will always leak. For boats of men-of-war, which in battle will have their planks opened by the concussion of the gun shots, perhaps these boats could be trusted to be in better condition in circumstances of the greatest urgency than those used to-day.

Very complete and important is the life-saving station exhibited by the United States Government, with the best boats, guns, carriages, and appliances produced in Europe and America, as a service where only the very best should be used, no matter where produced. That service is very popular in this country, and is a great credit to the Government because of the manner in which it is attended to. Some life-saving apparatus is exhibited by Drei, of Wilmington, Allen, of Massachusetts, and Müller, of Hamburg, but nothing so important as the hydraulic lifeboat of J. Green, of London, a real success in every form after a very severe trial, but its high price compared with that of common lifeboats has prevented the adoption of this powerful means more than is desirable, except in some localities where frequent disasters should call for more powerful relief than can be given by the ordinary pulling boat.

The excavators, dredges, and shovels in their special application to

marine purposes are scarcely represented in the World's Fair. There are some few models of canal excavators and dredges. In the United States they have been used on a very large scale in canal building and railway construction, substituting mechanical for manual work. This exhibit in itself has importance as representing the usefulness of the practical employment of those instruments that are already over their experimental trials. The foremost exhibitors are one from South Milwaukee, one from Chicago, two from Germany, and one from England.

Very little can be said of marine engines in this department. Of modern engines there has been exhibited only one working model of a quadruple expansion engine by Denny & Bros., of London. The Bethlehem Iron Company, Krupp, Brown & Co., and the Continental Iron Works of Brooklyn, have exhibited shafts, propellers, boiler-plates, and corrugated furnace flues, besides some other different objects for engine construction. In boilers, the great problem of high-pressure steam and a boiler that answers all the military conditions required by war ships, there has appeared even less in the marine division of the transportation department. Not even the smallest reference is made to the great experiment which France is going to make on board the new iron-clad *Yaurebiguerry*.

The electric department of marine appliances has two special representations, the United States Government as owner and the General Electric Company as manufacturers. The United States Government on board the model ship *Illinois* has selected the best material now in use, with the exception of the switch-board that belongs to the Edison system. All the rest is manufactured by the General Electric Company. Only the maneuvring table for the searchlight can be described as a new design, but the great improvement consists in the constant use of electricity for everything, bringing into familiarity the use and working of it. On board of the *Illinois* there is a large battery of accumulators to be used by a reduced number of lamps when the dynamos are stopped after midnight; which plan, adopted in many ships already, is always to be recommended for economy, to save unnecessary strain to boilers, machines, and dynamos working continuously, and giving more rest to the persons whose work should stop at a reasonable hour at night.

The General Electric Company manufactures dynamos for the marine use, specially made to be worked at a moderate velocity and low tension, so as to have the best conditions for security and constant work. Their projectors with Mangin reflectors, made in Paris, are very good. All have regulators for their carbons, and some of these are placed horizontally so as to keep the arc light always in a focus of the projectors. Finally, they have a great variety of designs for details of lamps, side-light switches, and small electric appliances of every description.

Special consideration must be given to a very interesting working table for the searchlights that is established on board of the model ship *Illinois* in the exhibit of the General Electric Company. In this table, and by two working hammers, and through one electric motor that is in the stand of the searchlight, the light can be moved in any direction, it being unnecessary for the operator to be stationed behind the light, exposed to the enemy's fire, but they can be worked from the captain's turret. It is especially adaptable when the light is placed very low, as at present used, obviating the difficulties of misunderstanding and the indecision of the operator when he can not see the suspected object at which the light must be aimed.

Torpedo warfare is very little represented in the Exposition. Torpedoes are exhibited, perhaps, more to impress the public than to constitute a proper exhibition. Of the fixed torpedoes of the well-known Albot system there are only two models, but they are not complete. The fish torpedo is represented by the Lay, the Sims, the Edison, and the Howell. The last by the Government of the United States and the others by the Hotchkiss Company, who own the patents, and is refused specifications for the judges. Some of their torpedoes were not even complete, and no launching tube was on exhibition. Acting very wisely, the American Navy has just bought the Whitehead fish torpedo patent and the right to make them in this country. The Whitehead torpedo and its twin, the Sewartzkopff, were not in the exhibition, perhaps because there still remains several nations of the world to pay high prices for that deadly weapon which has already produced more money than would have been produced by the discovery of a remedy that would cure consumption, cholera, and yellow fever altogether.

Though not very numerous, the exhibits of marine charts are very good. The exhibits of Austria, Japan, and the Coast and Geodetic Survey of the United States are excellent; but the charts of the Geodetic service were not only good, but they have been made upon such an extensive plan, short time, and enormous expense that they are in these respects unique in the world, and deserve great credit, not only to those who made that magnificent work, but also to the nation which has given the great amount of money necessary to survey the whole coast of the United States by a great number of commissioners at the same time, in pursuance of a general plan. To this service belongs the U. S. S. *Blake*, anchored at the exhibition, commanded by Lieutenant Mentz, with the most advanced appliances for the study of currents and very deep soundings. That ship had very few visitors, but should have had many, as it was a lesson in itself; but visitors seldom went for that purpose. One could learn a very good and useful lesson in the apparatus of Lieutenant Pilsburg, who formerly commanded the ship, whose apparatus, while the ship was

at anchor in 3,000 yards, could be used in taking observations on the Gulf Stream. Not less interesting were the arrangements for getting specimens of life from the deepest sea—the self-recording electric instruments to determine the movements of the Atlantic. All these were more than very good; they were excellent, and bring the greatest honor to the American Government, to the Navy, and to the Coast and Geodetic Survey for their persistent work in behalf of science and humanity.

No dynamite gun was exhibited except the model of the *Vesuvius;* but as this ship has not been imitated, and many other ships of the usual types have been built since, we may suppose that it is yet in the experimental stage. Only a gun to throw dynamite air torpedoes has been exhibited in the marine section. The inventor offered with his gun to throw a man safely into the air with a parachute to take observations of the enemy; but I reserve my opinion till the inventor has made the experiment on himself and informs us of his impressions during his aerial trip.

It is not possible to make a complete descriptive study of minor exhibits, inasmuch as none of them is so complete as to show the development and tendencies of certain industries—as, for instance, the exhibition of steel, iron, hemp, and manila ropes, all very good, exhibited by different nations, but by very few productors, being impossible to ascertain in what ratio they are employed and what changes are being made.

The enormous quantity of pleasure boats makes an important exhibit, where one can find anything to suit any purpose of the builder. There were the Coston night signals—very good when the electric light is not at hand, and always useful in boats and small vessels. The exhibition of compasses and binnacles was of no importance.

There are two models of the Erie and Nicaragua canals that give a very good idea of both works; also plans in relief of the harbors of Calais and Dunkirk, and a set of models in relief of the military harbors of Spain, said by those competent to judge to be the best models of their class in the Exposition.

There are exhibited samples of pyrotechnics for marine signals, luminous buoys, antifouling paints, asbestus goods, and a greater or less quantity of the various materials which constitute the details of ships.

Though perhaps not belonging to this section, there were examined by the marine judges the exhibits of lanterns of the United States Government. These lanterns were manufactured by Basbier & Co., of Paris, and are very complete for their purpose; but there is one of them made from the plan of Captain Mahan, of the United States Engineers, which gives a varying number of flashes, so that each light may be distinguished by the number assigned to it in the list of

lights; which patent, if the experiments prove it to be practical, will be of the greatest advantage to navigators.

Being the Columbian Exposition, an historical commemoration, I must consider those objects connected with that part of history connected with Chicago.

The Essex Institute exhibited a collection of paintings connected with the history of the country, and also the historical society of Wisconsin.

The Argentine Republic has sent a sternpost, claimed to belong to one of the ships which visited the Rio de la Plata in 1538.

Spain has sent the magnificent book of Monteon, not yet printed, of which the eminent Professor Elgar states that nothing similar exists in the world. She has sent also the original charts of America, but the difficulties attending the proper custody in the Convent of Rabida of this valuable collection of charts, where are also the original documents connected with the discovery of America (also belonging to Spain), has resulted in their being examined by a very limited number of persons. Spain has also exhibited an astrolobe, falstef, and other instruments used by the navigators of the fifteenth and sixteenth centuries, from the naval museum at Madrid.

Russia exhibited some models of the barge upon which Peter the Great worked during his apprenticeship, who was "The grandfather of the Russian navy."

There are also exhibited some models of Chinese and other Oriental crafts, both of present and historic times, that are very useful for historical study, as they afford the means to know how difficulties were overcome in old times.

A boat is exhibited that is said to have been used in the time of Christ; but nothing attracted such attention as the *Viking*, of Norway, and the three caravels of Columbus from Spain, in their natural size, all of which came from the other side of the Atlantic. The *Viking*, built in Norway by public subscriptions after a model of a ship found buried at Sandefjord in 1880, supposed to be similar to the ship commanded by Lieutenant Ericson, who, tradition says, visited a land that is supposed to have been America, from Iceland to Labrador and from there a little farther south, although some suppose that Lieutenant Ericson found vines and discovered the coast of Massachusetts. There are some documents in the Vatican speaking of very poor lands of difficult access that might have been Iceland, and possibly only Norway. The Danish were there, the head of the Norse nation, and the enthusiasts might have gone on until they would swear that they had bishops and perhaps railways.

Beginning with the name of the Norwegian ships, and the model of another very similar exhibited in the German section, I must say that the Norsemen's ships were commanded by Vikings—the name of the

captain's rank, and not of the specimen of the vessels—the same error that would be committed to-day if we called the ironclad battle ship *Illinois* a lieutenant-commander because that is the rank of her actual captain. The ship is made with superposed planks united with bolts perfectly riveted, while the frames are bound to those planks by small pieces of roots of a plant, as if they did not know even how to make ropes in that time, which circumstance, compared with the plan of the whole ship, is in the most complete discord. The *Viking* has a jib which, as is known, was used only in the last century, and further, whether the north Atlantic with its prevailing west winds could be crossed and a return made without a compass is a matter for serious investigation; but be the truth what it may, they kept the secret so well that neither Columbus nor the Spanish people knew anything about it, for which kindness we must certainly be very thankful. From an historic point the actual *Viking* has come directly from the coasts of Norway, under the very intelligent direction of Capt. Magnus Andersen, who crossed the stormy North Sea in an open boat, proving that the daring navigators of this country of so great renown and history of Europe have not ceased to exist.

Now follows in the exhibition the three Spanish caravels, *Santa Maria*, *Pinta*, and *Nina*, composing the fleet with which Columbus discovered the new world on the 12th of October of the year 1492. The *Santa Maria*, the larger of these ships, was built after the most careful investigation by the Spanish academies of history and archæology, under the direction of two distinguished officers of the Spanish navy, Dr. Monleon and Fernandez Duro, and the two smaller by Lieut. W. McCarty Little, of the United States Navy. A great number of original documents that exist in the Spanish archives, with the inventories of these ships, has permitted a reproduction that may be considered at perhaps nine-tenths of the original ships. The *Santa Maria*, called *Nao*, as she was really more of a cargo ship than anything else, was built by the Spanish Government for the great celebration of August and October, 1892, and afterwards to be kept in memory of the centenary, but came to Chicago at the special request of the United States Government. She crossed the Atlantic under my command, sailing without any escort, and employing thirty-six days, the same number of days that Columbus occupied in crossing it. The *Pinta* and *Nina*, called caravels, from being smaller and faster ships, were built in Spain by the United States Government to complete the Columbian fleet. They were towed to Habana and then delivered to the Spanish navy, in order to have the caravels made in Spain, manned by Spanish crews to come from Spain, under, as nearly as possible, similar circumstances under which the memorable ships opened a new world to the white race. These three ships reached Chicago by way of the St. Lawrence River, and after remaining two

months at the Fair, the two small caravels were returned to the care of the United States, and the *Nao* (*Santa Maria*) was presented by Spain and accepted by the United States Government the 12th of September, 1893, as a token of the best friendship between both countries. The expedition of the Columbus fleet was under the special care and charge of the Spanish Government, the officers and crew were from the navy, and the ships allowed to display on board the old flag of Castile, in memory of that great exploit which has been saluted and honored by all nations of the world.

Besides the Nao Santa Maria, which I have just described, there were a great many models of it in the exhibition. There was one very good from the Spanish Government; three models of the three caravels from the municipality of Genoa—excellent models in history and workmanship. There are Santa Marias of very large dimensions and also of small, some made in wood and even in cut paper. There were paintings by hundreds, all proving the hearty interest of modern societies in that great historic memorial.

I consider that in these exhibits there are only two which may be considered to completely fulfill their objects, and these are the trans-Atlantic service and the pleasure craft. The trans-Atlantic service shows the greatest progress. It has proposed a ship which shall cross the Atlantic at the tremendous speed of 30 nautical miles an hour—that is, at the rate of 31 statute miles, with which some of the northern railways cross the American continent—and the competition will every day bring improvements and progress. That this competition exists is evident from what appears in the exhibition.

The show of pleasure craft can not be more complete, and the competition can only be in quality and price, and advancement will be surely appreciated by the great number of amateurs. The other exhibits, as I have said, are all very good and characteristic of peace. There were not those great displays of military industries that fill other exhibitions, with the exception of the Illinois, exhibited by the United States Government; and other ships of war are exhibited by their builders as a product of their industry. The exhibition of naval warfare is more naval than warfare, and though everybody will profit by the many lessons that can be learned in the exhibition, I am sure that the naval industries of peace will have the greatest progress as a consequence of the great display of 1893.

WOOL.

1503

NEW SOUTH WALES WOOL EXHIBIT.

By HENRY G. KITTREDGE.

The foreign-wool exhibit at the World's Columbian Exposition had a twofold interest to Americans, because of its great intrinsic merit and of the part it is likely to play in the near future in the manufacturing industry of the country, as representative of the wools that will enter our ports in large quantities free of duty. No finer exhibit of foreign wools was ever before seen in the United States. The Argentina wool exhibit was a revelation to our manufacturers for its great excellence, more because of their unfamiliarity with the wools which the exhibit represented than for any particular points of superiority which it possessed over that from Australia. In case of the importation of wool free of duty, the Argentina wools, both the Merino and the cross-breds, will be more seriously considered for our manufactures than would have been the case had no exhibit of this kind been made.

It is my purpose, however, to confine my remarks to the wool exhibit of New South Wales, with an occasional allusion to that of Victoria, Australia. The colony of New South Wales is the mother colony of the Australian group. Her wool exhibit was under the immediate charge of Alexander Bruce, chief government inspector of stock in the colony, and for the past forty years identified with the pastoral industry of Australia. To him is due the credit of eradicating the scab disease from among the sheep flocks of New South Wales by strictly enforcing the law requiring thorough dipping of sheep at shearing time in prophylactic decoctions.

The New South Wales exhibit contained representative wools from all the sheep districts of the colony except those of Cobar, Ivanhoe, and eleven small districts, whose flocks numbered in 1891 2,400,000 sheep. Thus less than 4 per cent of the number of sheep in the colony were unrepresented at the Fair, and this small proportion was confined chiefly to the uninviting region between the Lachlan and Darling rivers. There are 63 sheep districts in New South Wales and 20 wool districts, containing altogether, according to the 1891 stock returns, about 62,000,000 sheep. By reference to the map the various wool districts, or 19 of them, will be seen indicated upon it. It will be observed that the railway intersects most of them. The wool

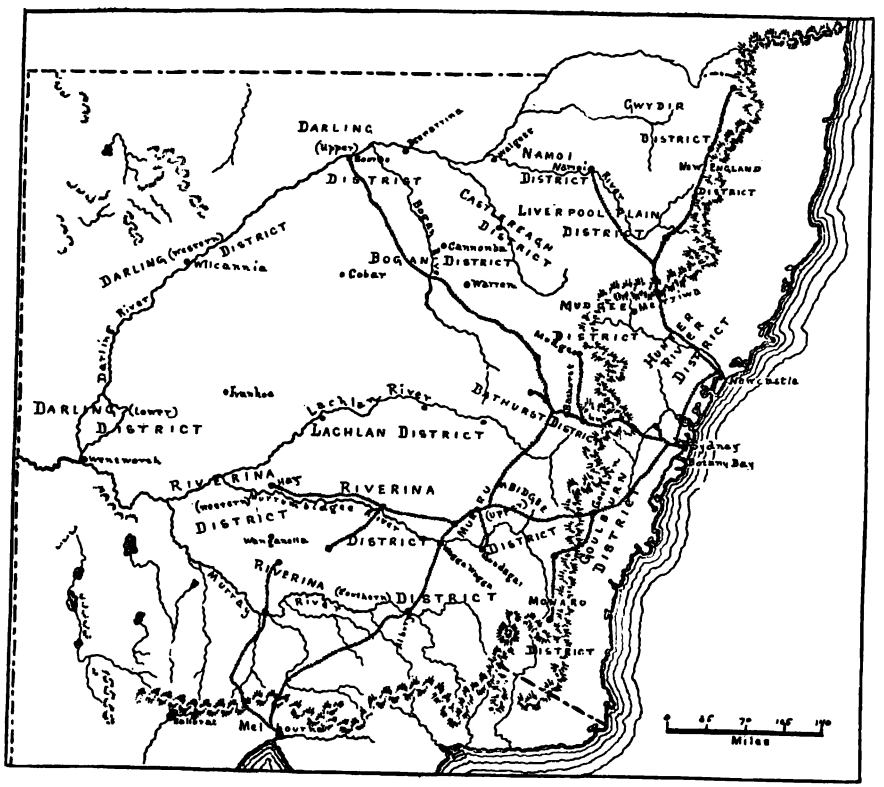
districts, according to their importance in the number of sheep, are as follows:

	Sheep.		Sheep.
Lachlan	5,452,571	Gwydir	2,856,598
Riverina	5,231,146	New England	2,581,642
Upper Murrumbidgee	5,099,381	Bogan	1,709,055
Upper Darling	4,808,672	Monaro	1,439,841
Western Darling	4,745,382	Mudgee	1,181,644
Southern Riverina	4,101,115	Hunter River	695,152
Castlereagh	4,076,196	Goulburn	641,428
Liverpool Plains	4,055,365	Lower Darling	631,176
Namoi	3,909,830		
Western Riverina	3,267,946	Total	59,463,990
Bathurst	2,979,550		

Over 37 per cent of this number of sheep are in the districts between the Lachlan and Murray rivers; over 24 per cent in the northern districts, from Castlereagh River to the upper tributaries of the Darling River, and nearly 14 per cent in the upper and western Darling districts.

There are about 13,200 sheep owners in New South Wales; 750 of these own over 62 per cent of the whole number of sheep. The flocks owned by these large proprietors range in size from 20,000 to 500,000 and 600,000 sheep. Seventy-three of these own nearly one-sixth of all the sheep in the colony, distributed among the different wool districts as follows: Seventeen in the Riverina and Lachlan districts, owning 2,528,704 sheep; 15 in the Upper Darling, Bogan, and Castlereagh districts, owning 2,548,384 sheep; 19 in the Gwydir, Liverpool Plain, and Namoi districts, owning 2,440,785 sheep; 18 in the Western and Lower Darling districts, owning 2,420,398 sheep, and 4 in the district about Cobar and Ivanhoe, owning 454,503 sheep. The great flocks are west of the western slope of the mountain range.

The various breeds of sheep in the colony are the Merino long-wooled sheep, as the Lincoln, Leicester, Downs, and Romney Marsh, and the crossbreds, principally the long-wooled breeds with the Merino. Over 97 per cent of the sheep are Merinos. Over 70 per cent of the Merino sheep yield combing wool, the remainder yielding clothing wool. Over 17 per cent of the combing-wool sheep produce a superfine grade of wool, and about 46 per cent a medium grade. Of the long-wooled sheep the Lincoln is in the greatest favor, though the Leicester is in no mean repute. It is generally thought among the flock masters of Australia that there is no room for improvement in the quality of the Merino fleece by any further admixture of European or American blood. Some efforts have been made in the direction of building up the avoirdupois of the animal, but they have not proved generally successful, as deterioration in the quality of the wool has followed. Large carcasses for mutton, as experience has demonstrated



WOOL DISTRICTS OF NEW SOUTH WALES.

the world over, are inconsistent with superiority in the fineness of wool.

The geographical position of Australia is a grand one, an ideal one for sheep husbandry, where the climate is neither too hot nor too cold, tempered by the breezes that come over the surrounding sea, and where the air is clear and dry. On the east coast there is a chain of mountains, generally known as the Great Dividing Range, extending north and south some 1,500 miles, in many places coming within 30 miles of the ocean, and touching it at Point Danger, between Queensland and New South Wales. Its highest elevation is in the southern part of New South Wales, where Mount Kosciusko rises 7,120 feet above the sea level, and where snow may be found at all times of the year. The colonies of New South Wales and Victoria occupy the choicest parts of the continent, where the climate is congenial and where the best lands are to be found for pastoral and agricultural pursuits.

New South Wales is divided into three physical divisions, designated as the coast district, the mountain district, and the western district. The latter two we shall have most to do with in connection with my subject. The coast district is a narrow strip of land from 30 to 150 miles wide, watered by a number of small streams having their sources in the mountains. The home of the mutton breeds of sheep is distinctively to be found here. The mountain district embraces the highlands and elevated plains that extend the whole length of the colony and slope gradually toward the west. This district varies in width from 120 to 200 miles. With the extension of the railway system and the increase in population this district is becoming more agricultural and less pastoral. The soil is rich and highly productive, the herbage is excellent, and were it not for the higher wants of agriculture the land would be taken up from choice for the pasturage of sheep instead of that farther to the west. The western district includes all the area from the elevated plains to the Darling River and beyond. All this region is now given over to grazing purposes, and with a general system of irrigation, as is now in contemplation, it will become equal, if not superior, to the most beautiful parts of the colony for husbandry of all kinds. As it is, sheep thrive there in a remarkable degree, very largely on account of the dry and healthy character of the climate. All the great rivers of the colony are found in this district.

From Bathurst, northward to the twenty-fifth degree of latitude, all the western streams are tributary to the Darling River. This river is navigable from Walgett to its junction with the Murray River, 1,758 miles, thence to the sea. At some periods of the year its waters are very low; but four, and oftentimes twelve, months' navigation can be depended on as far as Bourke. This allows the transportation of wool

and other things at certain seasons. The Murray River and its tributaries form the most important river system in the colony. The Murray has never been known to be dry, being fed by the heavy rains and snow on the mountains about Mount Kosciusko. This perennial flow in such steady volume can not be said of any other stream in the colony west of the mountains. It is navigable from Albury to the sea, 1,703 miles. The Murrumbidgee River is navigable up to Gundagai, while the Lachlan is navigable for several hundred miles. The great triangular region in the western district, lying between the Lachlan, Bogan, and Darling Rivers, has no surface streams. It is a comparative desert, yet some of the flocks of sheep in Australia are pastured there, about Cobar and Ivanhoe. The wools of this section were the only ones of New South Wales not represented in the World's Fair exhibit. The country northwest of the Darling River, notwithstanding its undulating formation, has also no surface streams of consequence, and the few streams there have their beginning and ending in the sands, excepting at occasional flood times, when one or two of the principal ones empty their waters into the Darling. Were it not for this lack of surface water the western plains of New South Wales would be the finest pastoral country in the world. This objection, however, bids fair to be overcome at no very distant time by the sinking of deep wells, by means of which the underground waters can be brought to the surface in abundance. Experiments have been made in this direction sufficient to establish a reasonable amount of certainty that it is possible to obtain an unfailing supply of water from below the surface.

The region west of the Lachlan and Bogan districts is the saltbush country of New South Wales. It is not regarded with particular favor for the raising of fine-wooled sheep, on account of the heat and the vegetation peculiar to a light, sandy soil of saline characteristics. But this region is improving, as the country east of it has improved and is improving, for both pastoral and agricultural purposes. All of this broad expanse of country is for the Merino, not the mutton, sheep. While the Merino sheep will not thrive in the coast region because of the climate being too moist, the mutton sheep will not thrive in the interior on account of the climate being too dry. But the mutton breeds are not good for a new country, for reasons distinct from climate.

The climate of Australia has had a peculiar influence upon the fleece and fiber of Merino wool, improving it in most all particulars. The wool has been made softer and more elastic. If there has been any deterioration it is in the density of the fleece; but this has been made good in a large degree by increased length of staple, so that there has been little or no loss in the weight of the fleece. It is difficult to say in what locality climate has had the most beneficial effect upon the fleece of the Merino. Certain it is that no place has been found

superior in this respect to the Mudgee district, where an experience of over sixty years has shown that no better wool has been grown than there. So far as experimental knowledge goes this district may be considered as possessing all the essential elements for the superior growth of Merino wool. The mean annual temperature of Mudgee is about the same as that about Nice, in southern France. It is very much like that of the great sheep walks of Spain. The mean maximum temperature in the hottest months is about 86° and the mean minimum temperature in the coldest months is about 38°, taking the records of 1891 as a standard.

The rainfall for that year was 34 inches, but this was 27 per cent above the average, the mean annual rainfall being nearer 26 inches. The mean annual rainfall in the Bathurst (24), Upper Murrumbidgee (23), and Liverpool Plain (25) districts is about the same—a few inches less. The mean annual rainfall through the Darling River Valley is 12 inches at Wentworth, 13 inches at Wilcannia, 16 inches at Bourke, and 19 inches at Walgett. In the Bogan district the mean annual rainfall is 17 inches, while about Cobar and Ivanhoe it is only 12 inches, but through the Riverina district it is from 26 to 28 inches.

Ever since 1820 there has been a constant improvement in the breeding and preparation of wool for the market. It was about this time that sheep breeding was commenced in the Mudgee district. In 1860 special attention was directed toward improving the fineness of the wool, owing to the increased demand for it at relatively high prices. This led to the importation of French, German, and American blooded Merinos, of the Rambouillet, Negretti, and Vermont types, respectively. The German and American Merinos were in special favor, chiefly for the density of their fleece. Improvement in the length of staple soon fol lowed, because of the increased demand for it for combing purposes. A change in the style of breeding resulted in more attention being given to purely Australian-bred sheep, which were found to possess special qualifications for the growth of long-stapled wool, not observed in those imported from Europe or America.

The French, German, and American bloods, however, were conspicuous in the specimens of New South Wales wools at the World's Fair. The Vermont blood was found almost if not wholly pure in some of the specimens from the Gwydir, New England, and Riverina districts. It was prominent in crosses with Australian types of wool, known as the Wanganella, Collaroy, and Tasmanian. The German blood was found almost pure in specimens from the Hunter River and Mudgee districts. The Collaroy blood, being the name of a stud flock at Merriwa, is derived from a Rambouillet and Saxon cross, and appeared to be a favorite infusion in many of the specimens from the Upper Darling, Gwydir, Namoi, and Monaro districts, and pure in many of the specimens from the Bathurst, Bogan, Castlereagh, Gwy

dir, Hunter River, Liverpool Plain, and Mudgee districts. Some of the Collaroy fleeces weighed 18 to 19 pounds. The Collaroy blooded wool is characterized for luster, evenness, and length of staple. The Collaroy and Brinley Park estates at Merriwa are famous for the high character of their Merino blooded flocks. The Brinley Park wool was represented by two specimens at the World's Fair. The sheep from which this wool was taken are descendants of a few rams and ewes imported into Australia in 1830 from Silesia. Subsequent importations were made, one being made in 1860 of several rams from the renowned flocks of Prince Lichnowski. Great care has always been practiced in culling and selecting. This blooded wool secured high honors at the Philadelphia Exposition of 1876. The Mudgee district type of wool is noted for the comparative density of its fleece. It possesses certain distinctive features that give it a classification of its own, and as such was better represented in the wool exhibits at the World's Fair than that of any other. It appeared pure in specimens from nearly all the districts, or crossed with the Tasmanian and other bloods. Another well-known blood in the Mudgee district, the Havilah, was represented in a single specimen—one bale—at the Fair, but it failed to attract particular notice. The sheep from which the wool was taken had been pastured on poor soil, badly infested with grass seed. The blood, however, is in good repute in Australia for producing wool that is lustrous and supple and suitable for worsted and hosiery yarns. The wools of Liverpool Plains are chiefly of the Tasmanian, Mudgee, and Collaroy types. In some of these there are traces of Saxon and French blood that was first imported in 1825 and afterwards renewed by some Negretti blooded sheep from Germany. These wools in time came to be regarded as pure Australian Merino wools, being improved from time to time by infusions of blood from the Mudgee district, as the Collaroy, and from the famous stud flock of the Ercildoune estate, Burrumbeet, Victoria. In regard to the Ercildoune wool it may be well to state that the sheep can trace a pretty direct lineage from the first great importation of Spanish Merino sheep into Germany, in 1785, by the Elector of Saxony.

A portion of the electoral flock was afterwards purchased and taken to Tasmania, and from the Tasmanian flock thus established a few sheep were taken, in 1838, to start a flock upon Lake Burrumbeet, near Ballarat, that afterwards came to be known as Ercildoune. This latter flock has undergone much classing and selection, till its wool has attained a standard of quality for fineness, elasticity, softness, and luster that has no superior. It is highly esteemed for mixing with silk. Some of this wool can be spun into worsted as fine as No. 140. In order to accomplish this the wool would have to be as fine as the finest Silesia and Saxony. This means that one pound of this yarn will extend over 44 miles in length. Victorian wools are in more or

less favor with American manufacturers. Take the wool, for instance, grown in the neighborhood of Ballarat, as the Lismore wool, which is prized for its light condition and strength of staple. It commands a high price for worsted and hosiery purposes. This wool will spin into Nos. 60 and 70. Victorian wools are characterized by their bold and lustrous qualities, while the Riverina wools are esteemed for their soft and silky properties, and the South Australian for their length, strength, and metallic brightness, with a tendency toward coarseness.

The wools in the Naomi district, New South Wales, are very much of the Walgett type, as represented in some specimens seen at the World's Fair. These wools are raised with special reference to the country in which they are grown, the fleeces being dense and the tips inclined to fuzziness, preventing the heat and dust from penetrating into the fleeces and thus injuring the wool. These qualities are secured by certain crosses of Victorian, South Australian, and Riverina bloods. An objection has been raised concerning these wools on account of their hairy or fuzzy tips producing an excess of noils, yet they are capable of producing good worsted yarns of Nos. 60 to 70. The wools grown in the upper Darling district, as about Brewarrina, are similar to those about Walgett; that is, the fleeces have more or less fuzzy tips. Yet this style of wool is looked upon as particularly useful, considering the circumstances under which it is grown. The heat and dust to which the sheep are exposed have a tendency to produce open, loose, hairy tips. Fineness of fiber is not arrived at, but a fiber of medium quality, of good length, that will spin down to about No. 60. Bogan district wool is not unlike that of the neighboring districts, being of medium grade, spinning into the fifties and in some instances into the sixties. The fleeces are apt to be light on the tip, and therefore noil considerably. The wools of the western Darling district show more or less poverty in the better characteristics of Australian wool. The summer heat is unpropitious for the growth of heavy fleeces. Every effort is being made to improve the wool by the introduction of blood from the best stud flocks of Victoria and South Australia, particularly the latter. It is doubtful if wools of the first quality are ever raised in this section. A fuzzy tip characterizes the fleece. The Riverina districts produce a variety of grades of wool. Some of the best grown in Australia are produced there. Take, for instance, some of the wool exhibited at the Fair from Wagga Wagga, in which Vermont and Mudgee bloods were prominent. The specimens represented a superior type of combing wool. Some of the most perfect wools in the world are produced in this district, being bright, silky, fine, and lustrous. The wools of the southern Riverina district at the Fair were of a high character. Those from Mulwala, west of Albury, were particularly noticeable. These came from a flock of

sheep descended from Mudgee, Ercildoune, and Tasmanian blooded stock. Trade objections have been made to some of the wools from this section because of a wasty top, causing a large percentage of noils. Seasons, however, have much to do with these defects.

The heaviest fleeces of Australia come generally from Victoria. They become lighter as one goes toward Queensland. The fleeces are more open and freer from yolk. This applies more particularly to the wool grown in the western districts of New South Wales. The average weight of Australian fleeces from stock sheep may be put at 6 to 7 pounds. A plain, not wrinkled sheep is preferred. The advantage of the infusion of American or Vermont blood is that it imparts a density to the fleece which it is difficult to get from the Tasmanian or Mudgee blood. The objection to it is that it gives to the wool a harsher feeling, and the staple is shorter than that obtained from the stud flocks of purely Australian blood.

The great superiority of Australian wool is supposed to be due mainly to climatic conditions, but no little credit is also due to the grasses and herbage upon which the sheep feed. The native grasses of Australia are looked upon as superior for pasture to exotic grasses. Experience has inclined opinion that way. They possess greater reproductive powers, and there is very little necessity for reseeding. The most abundant variety of grass is that known as the Kangaroo, which not only supplies the sheep with nutritious food, but is capable of resisting heat. It is found over all portions of New South Wales and Victoria, and is perennial. It is pronounced by all as being one of the finest and most useful of grasses for pasturage. It sometimes attains the height of 3 feet when on rich soil. In the autumn, when its foliage turns brown, its nutritive qualities are said to be at the highest, and when cut as the flower stems appear it makes excellent hay. There are other native grasses of great value, among them the millet, which is found throughout New South Wales and is much liked by all stock, and the small burr grass and the variety known as the Wallaby, both of which are favorites with sheep. There are some troublesome weeds in Australia, as the Bathurst burr—known in the United States as the cockle burr—the trefoil burr, and certain thistles. These are exotic, having been introduced from abroad. In the western parts of New South Wales there are indigenous grasses that are perennial, and possess fattening qualities even when dried up. The several varieties of the salt bush, a forage plant, grow there, thriving on the arid plains in most adverse seasons of heat and drought.

It is not to be presumed that the arid regions of Australia will always remain as they are now, of little value even for ordinary pastoral pursuits. The soil is undoubtedly naturally rich, requiring only a proper amount of moisture, properly distributed throughout the season, to become highly productive. To accomplish this most desired end a

general system of irrigation is contemplated, especially in New South Wales, involving the sinking of artesian wells and the diversion of water courses. In Victoria no efforts of any moment have been made to obtain water by means of artesian wells, but ditching has been resorted to, and immense tanks constructed for the conservation of rainfall against times of drought. To allow any material increase in the number of sheep in the interior regions it will become necessary to resort to some expedient of this kind to supply surface water for the vegetation. The sinking of artesian wells in New South Wales first received government attention in 1879, and the first practical effort made in this direction was in 1884, near Bourke, where a flow was obtained of 24,000 gallons a day from a depth of 89 feet. Other wells have since been sunk in different localities, in most cases with satisfactory results, in one instance obtaining a flow of 2,000,000 gallons a day. The government is working upon a system of boring series of artesian wells in two lines, one extending from the mountain range to the western boundary and the other from the Murray River to Queensland. The great river systems of the colony can, and unquestionably will, be utilized for irrigation purposes before many years pass by. It has been carefully estimated that the underground supply of water is all sufficient and obtainable by means of sunken wells to convert the arid regions into highly productive ones. Take, for example, the 200,000 square miles area drained by the Darling River. The average rainfall over this is 20 inches per annum, and even assuming that one-tenth of this finds its way into the Darling and its tributaries, in order to carry off the water the river would have to be 200 feet wide and 100 feet deep all the year round, which was never known to be the case even in flood times. The water, therefore, must sink into the ground and flow at a lower level. If this lower level can be reached and the water brought to the surface and distributed by economical means, the whole aspect of the interior districts of the colony will be changed and verdure prevail where aridity now exists.

Few sheep are now shepherded in Australia. The paddocking system is almost invariably in vogue. By this system the country is capable of carrying one-third more sheep, the fleeces are better in condition and in all other respects, and the wool is longer and stronger. The sheep themselves grow to larger size, live longer, and are freer from foot rot and disease. In addition to all this the expense of watching and caring for the sheep is less, and more time is at the command of the owner to devote to the improvement of his flock. In Victoria all the sheep stations are now inclosed by fences, and most of them are divided into paddocks. It has been found that more sheep can be kept and made to thrive on land under fence than when left open for general pasturage. Fencing has become a matter of preference as well as one of necessity. The question of cost is of

secondary importance; in fact, it is fully offset by the improvement in the health and condition of the sheep and in the less expense and trouble attending their care. The cost of establishing a fenced run or paddock is covered in five years by the saving in the cost of labor alone. At first fences were made of logs and brush, where these were obtainable, but now nothing but wire is employed in their construction, at a cost of from $125 to $150 per mile. The usual height of a fence is 3 feet, with the wire strung at intervals of about 6 inches, on stout posts set about 120 feet apart. Between these latter are placed smaller posts or stakes at distances sufficient to keep the wires in place. Some runs have several hundred miles of fences. These large runs are divided into many paddocks or inclosures. An average paddock is of about 800 acres in size. In New South Wales there are about 42,000 runs, of which over four-fifths are inclosed, and seven-tenths of these are subdivided into paddocks. The area comprised in these holdings is not far from 190,000,000 acres. This would make the average run of about 4,500 acres. Over 80 per cent of these holdings are leased from the colonial government. All, or nearly all, of the best sheep country in the Australian colonies is now occupied, and any additional increase in the number of sheep which the country can be made to carry must be effected by improvements in the way of irrigation and the character of the herbage. The management of a station consists usually of a manager, an overseer, a bookkeeper, and a certain number of boundary riders and common laborers, according to circumstances. The fencing in of sheep runs and their division into paddocks has had much to do toward the extermination of the scab disease among sheep. The last license for scabby sheep in Victoria was issued in October, 1874, and on June 6, 1876, the governor proclaimed the colony clean of the disease.

The extermination was accomplished through the rigid enforcement of the scab act of 1870, still in force, which requires certain medicaments to be used in the dipping of sheep, consisting of a mixture of tobacco and sulphur in water or of a mixture of lime and sulphur in water, the mixture in either case to be at a temperature of not less than 100° F. at the time of dipping. Two immersions are required at an interval of not less than seven nor more than fourteen days. The lime and sulphur dip is acknowledged to be effective, but it is regarded by sheep men as too severe, making the skin dry and the wool harsh. A preferable receipt, because of its milder action upon the skin and wool, yet equally efficacious for the eradication of the scab, is the tobacco and sulphur one at a temperature of about 104° F.

The loss of sheep on account of disease due to natural causes is almost as nothing compared with that caused by the multitude of rabbits that infest the land by eating up everything that is green and leaving nothing upon which the sheep can feed. With the exception

of drought, there is no impediment to profitable sheep husbandry so damaging as the rabbit pest. Colonial laws have been directed toward its complete elimination, at a great cost to those engaged in pastoral pursuits, with the great object of extermination still unaccomplished. The colony of New South Wales alone expended during the eight years ending with 1890 nearly $4,300,000 on account of rabbit destruction, and over 40 per cent of this was derived from assessments, the balance coming from the general revenue. There are various means resorted to for ridding the country of rabbits, such as trapping, poisoning the food and water, shooting, and hunting with packs of dogs. Some idea may be had of the destruction that has been going on among rabbits by the exports statistics of rabbit skins from Victoria. For the ten years ending with 1886 there were exported from that colony nearly 29,000,000 rabbit skins.

The shearing season in Australia depends on the location, beginning about the 1st of July in Queensland, and ending about the 1st of March in Victoria. Thus there is given fully eight months for shearers to ply their vocation, commencing in the northern parts and completing their season's labor in the southern parts. Four months are allowed for rest and return to the north. Much skill is required in the shearing and handling of sheep, and the compensation is rated accordingly. There is a large class of men who do nothing else but follow this employment, which is now subject to rigid regulations in conformity with an agreement reached in 1891 between representatives of the Pastoralists' Federal Council of Australia and representatives of the Amalgamated Shearers' Union of Australia. Both of these associations are strong in number and in their organization, and the 1891 agreement was the result of a number of seasons' dissensions, but more particularly the result of a general strike on the part of the shearers the year before, when in many instances sheep remained unshorn till long after the usual time. The main cause of the strike was the employment of "nonunion" shearers; but under the agreement employers are free to employ, and shearers are free to accept employment, whether belonging to shearers' or other unions or not, without favor, molestation, or intimidation on either side. The meaning of all this is "freedom of contract." In New South Wales the agreement establishes the price of shearing at 20 shillings for every 100 sheep shorn, except rams, for which 40 shillings are paid for every 100 shorn. The employer is bound to keep the shearer fully supplied with sheep unless prevented by weather or by some unforeseen cause, and also to provide him with hut accommodations, cooking and table utensils, wood and water, free of charge. Certain requirements are made in shearing. First, the sheep must be carefully taken from the pen to the shearing board and the belly wool removed first, where practicable, and laid aside. In opening the fleece at the neck and belly

both blades of the shears of the machine must be kept under the wool and close to the skin, so as to avoid twice cutting, and the shearer is not allowed to run the shears through the fleece so as to break it down the center or the back, or to stand on the fleece. The shearer is prohibited from kicking or ill using any sheep. He is forbidden bringing intoxicating liquor into the station or using profane or obscene language in the shed. Shearers are obliged to provide their own cook, except where cooks work conjointly for shearers and employer, in which case the cook is engaged mutually by the employer and shearers. No shearer can be compelled to work more than forty-eight hours a week.

Shearing by machinery is something of very recent date, long desired by the wool growers of the colonies. Of the 69 applications for patents on sheep-shearing machines only 3 or 4 have been received with favor, and at the Royal Agricultural Show held at Melbourne in 1891 only 3 competed for the prize offered—the Wolseley, Burgon, and 1 other. The special merits of the Burgon machine are represented to be overhead safety driving motion, which is self-adjusting in its action, and can be operated separately from others on the same line of shafting, and a flexible steel driving shaft made of hardened steel with universal joints. It requires an engine of 4-horse-power to drive 10 to 15 of these machines. The best-known machine in the colonies is the Wolseley, not dissimilar in essential principles to the one just described, and first brought to public notice in 1887. Since then it is calculated that at least 60,000,000 sheep have been shorn by it. There is a variance in the opinion of sheep men as to the economy and general advantage of machine over hand shearing, though the testimony seems to be generally in favor of the machine. The chief complaint against it is its vibration and the extra strength required in holding the sheep to the shears. For a flock of 30,000 to 40,000 sheep there are required 14 shearers, 2 packers, 4 sorters, 1 classer, 2 pickers-up, 1 sweeper, 3 or 4 general-utility men, 2 cooks, besides an engine driver, water hauler, and cutter grinder, in case the labor is done by machinery.

As required by the rules of shearing already referred to, the shearer is required to remove the belly wool first, if practicable. This wool is carried by the pickers-up to the bins provided for such wool by the side of those for pieces, broken fleeces, etc. The fleeces go to the sorters, who place them upon tables with wire-netting tops, the meshes of which are about 1¼ inches in size. The sorter is an important person, oftentimes one who has had experience in the sorting room of an English factory, and therefore skilled in the art of quickly judging the different qualities of which the fleece is composed.

The fleece is sorted with the cut side down, the loose locks falling through the meshes of the netting onto the floor. The sorter is under

the direction of the classer, who is the one chiefly responsible for the proper separation of the fleece into its several parts, an operation known among wool men as "skirting." After the skirting is all done the body of the fleece alone is left, and this is the only kind of wool that is sent to the American market. Technically, this is called the fleece, the rest being termed the first pieces, which are taken from the neck and from a portion of the skirts; the second pieces, taken from the upper part of the legs; the third pieces, taken from the cheeks, topknot, and lower part of the legs; the stained pieces, taken from the breach; the bellies, taken from the underparts, and the broken pieces, or trimmings, not included in the foregoing. After all these pieces, etc., are removed from the body of the fleece, the latter is folded lengthwise, rolled, and either tied with cotton twine or secured by twisting in an end of the fleece. The classer receives the wool in this condition and throws it into its proper bin, from which it is taken and pressed into bales of about 400 pounds in weight. Fleeces, whether Merino or crossbred, are classed as first, second, and third combing, or as first, second, and third clothing, as the case may be. Parts of fleeces have various designations, aside from first, second, third pieces, etc., as "dingy fleeces," "ram's fleeces," "tender fleeces, etc." This matter of sorting and classing wool is carried to an extreme, and, in the opinion of many, to an extent that is uncalled for. The stained bellies and locks from the fleece are generally scoured before being put upon the market. According to the record of one flock of sheep in the Riverina territory, the following proportion of classes and sorts was made: 47 per cent first combing, 4 per cent second combing, 2 per cent clothing, one-half per cent dingy and black, 19 per cent broken fleece, 4 per cent first pieces, 8 per cent bellies, 8 per cent stained, and 7½ per cent locks. Twenty-four per cent nearly of this clip of wool was scoured, and only 53 per cent was marketed in the form of fleeces.

The tendency is toward shearing in the grease, which is almost exclusively due to the price obtained for washed wool not being commensurate with the cost of washing. Over 96 per cent of the sheep shorn in New South Wales in 1891 were shorn in the grease; in 1880 the proportion did not exceed 70 per cent, 17 per cent being creek washed. The average weight of fleeces shorn in the grease in 1891 was 5 pounds 9 ounces, packed in bales measuring about 5 feet in length and 2 feet 2 inches in breadth and depth, and weighing about 450 pounds. The bales are afterwards subjected to hydraulic pressure and reduced in size about one-half before exportation.

Wool is transported from the stations to the nearest railway by wagons, drawn either by horses or oxen, twenty of the latter often being yoked to one wagon, upon which is loaded as many as 25 bales of wool, and in exceptional cases as many as 50 bales. The cost of cartage overland is at the rate of $1.25 for 100 pounds per 100 miles.

Should the distance exceed 100 miles, a discount of 20 per cent from this rate is made for the additional number of miles. The railway freight from Hay, for instance, to Sydney, a distance of 454 miles, is about 70 cents a hundred pounds of greasy wool; from Bourke to Sydney, a distance of 503 miles, the freight is about 98 cents a hundred pounds; and from Mudgee to Sydney, a distance of 195 miles, the freight is about 66 cents a hundred pounds. It is a matter of report that "not so very many years have elapsed since the Queensland squatter, after seeing his last wagonload started from his station for the coast, would take a run home to England, returning to the colony in time to meet his wool on its arrival at the port of shipment, so long and tedious was the journey. Drays and impromptu slides had to be made; creeks and rivers to be crossed; droughts killed off the bullocks for want of feed and water; floods converted the banks of rivers, etc., into 'tented fields,' populated by drivers, whose rations often ran low; bush fires menaced the safety of the men, cattle, and freight, besides the occasional attacks by natives; in short, wool, while in transit from the far-back stations to the seaport, had an adventurous and risky career. There have been instances of two different years' clips being on the road at the same time."

Freight rate from Sydney to London is from about 75 cents a hundred pounds by sailing vessel to $1.25 to $2 a hundred pounds by steamer.

Nearly all the wool sold in Australia is disposed of by auction to the highest bidder at the principal colonial markets. These sales have grown in popular favor and importance, having amounted to 697,705 bales for the season of 1891–92 for all the colonies. For that season 42 per cent of all the sales were effected at Melbourne and Geelong, and 40 per cent at Sydney.

The chief and almost only increase in the world's production of wool is in Australia. For the ten years ending with 1892 the wool production of Cape of Good Hope increased about 36,000,000 pounds, that of the Argentine Republic about 66,000,000 pounds, and that of North America about 13,000,000 pounds—in all about 115,000,000 pounds—while that of Australia increased about 278,000,000 pounds, or over 70 per cent of the total increase. These figures are based on the imports of wool into Europe and North America; where they are alone manufactured and where they are wholly shipped. Practically the wool production of the world seems to be stationary or on the decline in all wool-producing countries except Australia. Nearly 30 per cent of all the wool consumed is from the flocks of Australia, and this proportion is increasing every year.

I had been in hopes of presenting in this paper some of the results of the scientific experiments that have been conducted under the supervision of Dr. William McMurtrie, affecting the wools at the World's Fair, but they are not yet ready for publication.

WOOLS AND OTHER ANIMAL FIBERS.

By WILLIAM MCMURTRIE, E. M., PH. D.

PREFACE.

It is of course natural that differences more or less extended should prevail between the products of countries so widely separated and so different in their physical as well as their social and economic features as those represented in a world's exposition, but a careful study of the relations of these differences must develop laws of value to all concerned in the great industry of wool production and so add to the sum of knowledge and stimulate immediately the progress of the future. The influences of climate, soil, food, care, and general treatment have each of them a marked influence upon the character of the product, and while these are necessarily interdependent, and while all the conditions may not prevail or be maintained with equal intensity everywhere, it is evident that modifications of one or the other should be determined from careful study of the facts to the end of bringing about not only an improvement in the quality of the product, but in its quantity as well.

Demand undoubtedly influences largely the character of the product of any country. In those countries in which flesh production predominates and wool production is secondary the quality of the staple must of necessity, and particularly as regards its fineness, deteriorate. This condition is growing both in this country and elsewhere. For our own country it is manifest in the exhibits offered in this Exposition, and States which have been justly celebrated for the production of fine wools have sent exhibits consisting in great part of wools from those breeds producing large carcasses and coarse staple. It is also apparent that the breeders who are devoting themselves to the fine-wooled breeds are giving greater attention to the development of large, strong, sturdy frames and acceptable pelts rather than to the production of animals yielding excessively fine fiber. These animals are more useful for transmitting good constitution, larger frame, and physical vigor to the finer wooled and generally less hardy strains. Yet while this is in a great measure true, examples are by no means wanting in this country in which both these conditions are found in the same individual, and we have reason to believe that what has here-

tofore been considered practically unattainable will be realized, and that a large body and very heavy fleece may be combined with extreme fineness of the wool. And possibly, too, a large carcass of good mutton may be found in an animal producing an abundance of fine wool. Almost the finest wool from the United States was produced upon a Merino sheep weighing 300 pounds.

But if the fine-wooled breeds are giving way in this country to the larger and coarser wooled mutton breeds, we are not alone in this particular. The frozen-meat shipping industry is growing with startling rapidity in the Argentine Republic and Uruguay and in the English colonies of Australia, and it is fair to say that the day is not far distant when most extensive changes in the character of the flocks will be realized in these countries which have thus far been the strongholds of fine-wool production and have been considered the principal sources of the supplies of this important commodity. We see, therefore, that there are conditions other than fiscal which are likely in the near future to have an important influence upon the profit in breeding and management of fine-wooled sheep in this country, and our sheep growers will do well to take them into account.

It can not fail to be a matter of regret that the exhibits from our country in the group and class in which we are interested is so limited. It is a lamentable fact that serious general apathy with regard to the exhibition of a large and representative collection of the fine wools of the United States should have prevailed among the breeders of fine-wooled sheep and the producers of fine wools. Under the circumstances it seems almost remarkable that even so large an exhibit as was presented should have been made. Instead of the matter being taken up by the associations of breeders and of woolgrowers early in the years preceding the Exposition, and of preparing collections of good, clean, strong wool, such as would easily be obtainable in such a way, it was not an uncommon complaint among the commissioners from different States that in order that the wool-producing industry might be represented at all it was necessary to go into the open markets and purchase fleeces of whatever might be available, but a short time previous to the opening of the Exposition, so making it impossible to secure what was finest and best. That most excellent work is being done is manifest in the quantity and high quality of the fine wool finding its way into the market, and it is particularly unfortunate, in view of the provision that was made for the extended study of the physical properties of the staple, that such a condition of affairs should have prevailed. The industry of wool production is so important, and the reputation for high quality of the staple from many sections of this country is so high, that under all the circumstances it amounts to a serious misfortune.

And it is also to be regretted that many foreign countries in which

woolgrowing has reached a high state of development and the product obtained is of such excellent quality failed to add to the collections in this line. This is particularly true of Germany, which has developed the Saxon and the Negretti races of Merino and whose naturalists have made such classical researches into the structure and physical properties of the staple; and of France, whose national stud has maintained the purity of the Merino race and developed it into the world-renowned Rambouillet strain. It is further a matter of regret that the exhibits of Spain, the original home of the Merino, should be confined to the product of a single grower, and that the same should be true of Russia, from which in the earlier exhibitions such splendid exhibits of fine wools have been sent. But the colonies of Great Britain, and the Republics of the South, so largely devoted to animal production, with their accustomed enterprise, furnished excellent examples of their work, and showed clearly what intelligence and energy may accomplish in the production of good stock.

It has been our endeavor in this work to make as full and complete measurement of all the physical properties of all the fleeces exhibited as the limited time available for it would allow. The quantity of material furnished by the exhibition was sufficient for the work of a year at least, and some means should be provided whereby someone interested and capable could take it up and work out all the relations of practical value to either the breeders or the manufacturers. It is our hope, however, that the results here presented may be carefully studied by both these classes so vitally interested in the staple, and that each one may be able to determine for himself facts of value in his own work, and of interest for communication to others for mutual benefit and profit.

It is also to be hoped that in future exhibitions the plan here followed may not only be carried out, but that it may be extended. Such an examination begun in the early months of a summer's exposition, with ample preliminary preparation, could very well be carried to such a satisfactory conclusion that the results thereof could be made the basis of the system of awards. It would eliminate the empirical methods necessarily inherent in the ordinary methods common to all examinations for awards, and would make absolute comparisons between exhibits thoroughly possible. This is illustrated in the work of the judges of group A, class 60, of the Columbian Exposition. No committee of judges of awards could be more thorough or more conscientious in their examinations than were those appointed to it; yet comparisons of the results we have to present with the awards of the judges will show that, in spite of the care and judgment that may be exercised, the many and varied conditions that prevail may so interfere with reaching accurate conclusions by such empirical methods that wide differences must of necessity prevail between them and the

results arrived at by mechanical means and with instruments; yet it is interesting to note that in this case, while differences do prevail, the work of the judges has been most skillful, and that for the greater part the estimates arrived at are justified by the results obtained with the instruments. Combination of the two methods would provide almost perfect means for award work, and furnish a system practically free from the perplexities of those usually adopted when carried out by conscientious men. It must, therefore, be apparent that, in spite of the difficulties that were met and perhaps not too thoroughly overcome, the executive committee on awards, through its chairman, acted wisely in undertaking to establish this combined system in the great Exposition just closed. The experience of this Exposition in this particular can not fail to be of value for the future, and the results secured, even if confined to this extent of value alone, would be sufficient reward for the efforts that have been expended to make it successful now.

Several suggestions resulting from the experience gained by the judges in their work in this class have become more or less prominent. It is admitted that it is difficult to secure thorough cooperation of producers in preparing a comprehensive exhibit of the products in a given class, but it must be admitted that such cooperation is greatly to be desired.

First, it is important that early in the preparation for such an Exposition as that just ended, a most thorough and extensive classification of the material likely to be entered should be made. Such classification should be made not by one versed simply in the matter of museum arrangement, but by one skilled in the handling of the materials themselves, and having full knowledge of the different qualities which these materials present. In such an Exposition products are offered and must be judged from two widely varying standpoints—that of the producer and that of the consumer. And these two standpoints involve two systems of classification, one systematic and scientific, covering all the conditions of production and the results thereof; the other commercial, covering the uses to which the product is to be put. And the exhibits should be separately judged from these standpoints, each exhibit in its preestablished class. It must be evident, therefore, that for the purposes of systematic study and for the work of the judges of award, if such thorough and extended examination and comparison is to be undertaken as it was attempted to carry out on this occasion, such classification as is here suggested, arranged and established by special experts in each class, and worked out in the fullest detail, should be published and presented to intending exhibitors, to the end that they might intelligently prepare and arrange their exhibits and be fully instructed with regard to the conditions of comparison and competition they will be compelled to meet.

Next it is important that the exhibits in each class should consist of more than one example of its kind. For instance, suppose an exhibit of pure-bred Merino fleeces; from the breeder's standpoint it would be manifestly unfair to compare a ram's fleece from an animal 5 years old with a ewe's fleece 2 years old. Nor should it be considered sufficient that a producer should have any class of his wool represented by a single fleece. In many cases only a single fleece of value is available, the remainder of the product being of low grade. The exhibit would not, therefore, be representative. It would be better to require that each class should be represented in each exhibit by at least five fleeces; for instance, five rams' fleeces from animals 2 years old. This plan would serve a double purpose of insuring representative exhibits, and if such systematic examination of the exhibits as we have carried out on this occasion is to be applied there may be sufficient results to enable the examiner to secure reliable general averages of the results for each class. The increase in the knowledge of the ultimate quality and value of the staple to be obtained in this way would be almost inestimable.

Furthermore, in fixing the standard of each exhibit the yield of clean wool should play an important part. In the preparation of wools for exhibition the endeavor to secure large volume as well as large weight leads to practices not always creditable to the exhibitor. Regulations should be provided in the systems of classification and examination as to insure the thorough abolition of such practices. To the producer, other things being equal, quantity becomes the important consideration, and if the comparisons in this particular are to be referred to a perfectly cleansed product no opportunity for unfavorable comment or criticism can arise.

In addition to all this it should be required that in all cases the fullest information concerning the history of the material exhibited should be furnished with it. The value of an exposition of the products of the world consists not only in the opportunities for personal examination and inspection of the products themselves but also in the subsequent study of all the relations tending to the development of the standards exhibited in the products themselves. It is only by such means that mutual benefits may be attained and the work elevated above the plane of an ephemeral show.

COLLECTION OF THE MATERIAL.

Upon organization of the committee of judges of awards for wools it was determined that the examination to be made with regard to the results of breeding and the commercial qualities of the staple should be made in accordance with a scale of points agreed upon after most careful deliberation, and that in carrying out this plan each fleece exhibited should be opened up and each part thereof carefully studied. This scale of points was as follows: Density, 16 points; even-

ness and fullness of covering, 20 points; brightness, softness, and yolk, 14 points; wave, freedom from kemp, and fineness, 16 points; strength and elasticity, 14 points; evenness of quality of wool all over, 20 points. Total, 100 points. It was determined further that a record should be made of the breed of sheep represented, the sex, age, and weight of the animal, the age of the fleece and its weight, and the length of the staple.

To carry out this plan of examination each fleece was taken from its place and spread upon a table by experienced wool handlers specially employed for the purpose, and the various points of excellence determined so far as this was possible by handling, and the application of the ordinary mercantile tests. This examination was carried on very much after the method followed by commercial sorters, and the estimates of value were made only after the most careful consideration. When the examination was completed, and before the fleece was again rolled up to be returned to its place, a portion covering an area of possibly 3 by 8 inches, and making a good handful, was taken out for the purpose of the minute examination of the physical properties. In order that this examination should be as nearly as possible representative of the fleece, it was taken from that part of the fleece lying just back of the shoulder and off the back. This part was selected because in the former examinations of wools it had been found that although the length of the staple found here is not as good as that from the shoulder, and often not as good as that from the hip, it is not as poor as that from some other parts of the fleece, and that it is fairly representative of the average for the entire fleece. And since it was taken from as nearly as possible the same position in each fleece the results of the examination must be fairly comparable.

As soon as the sample was taken it was inclosed in a box of manila cardboard about five inches square and one inch thick. It was suggested that because of the possibility of the absorption of grease of the wool by the paper of the box it would be better to inclose the samples in tin, so that in case it should be considered desirable to determine the quantity of grease contained in the sample and so the possible loss of the fleece in scouring no loss by absorption would have occurred. But since such determination would be of little practical value because in this particular the sample taken could not represent a fair average of the fleece the use of tin became really unnecessary, although in this instance a number of tin boxes were really used. Experience, however, showed that the paper of the boxes absorbed almost no grease, or at least so little that if determination of the grease had seemed desirable vitiation of the result from this cause would not have occurred.

The paper boxes are more desirable on many accounts. They are less heavy. They are sufficiently strong. Notes may be inscribed upon them and they may easily be packed for shipment or storage. Fur-

thermore, they may be most convenient for classification and preservation of the samples during the examination in such a way that any sample needed may be readily found.

When each sample was taken and was put into its box there was inclosed at the same time with it a label bearing all the information which accompanied it and had been required by the Exposition authorities and the data recorded by the judges. As a measure of precaution, which afterwards proved most useful, this information was likewise copied upon the outside of the box. This duplication of information is most important, especially when a large number of samples is to be taken and so much depends upon the extent and character of the information furnished with the fleeces in the subsequent examination. In this Exposition the information thus furnished, with a few important exceptions, was generally most complete and satisfactory and very faithfully given. We have endeavored to enter in our tables of results all the facts concerning the fleeces thus secured, and they will be found exceedingly useful in connection with the study of the relations that may be worked out.

The samples so taken and inclosed were packed in cases and shipped to the Pratt Institute in Brooklyn, N. Y., where through the generosity of the Messrs. Pratt ample provision for the prosecution of the examination was made. It was at first intended that only a limited number of samples should be taken, say 100 or 200 in all, considered sufficient to represent the qualities of wools in the exhibits from the different countries and sections, but the extent and variety of the exhibits and the difficulty of rapidly making the proper selection of samples during the examination of the fleeces for the purposes of the awards made such a plan impracticable. At least 10 samples from each grade or quality of wool, or of the wools of each country, would be necessary to establish averages of any value, thus bringing the number of samples necessary to be taken largely in excess of the bounds mentioned. Altogether it was deemed better, therefore, to take as far as possible a sample from every fleece examined by the judges, and even of many not entered for competition, so that after the examination had been begun and was fairly under way such selections could be made as the requirements demanded and the time available allowed, and if possible all might be examined, making a record never before attained in any exhibition, and a series of results which could not fail to be of the highest value if properly studied, either from a commercial standpoint or in the interests of the breeders. In all something over two thousand samples were collected, and it is a source of satisfaction that in spite of the brief time available and the difficulties experienced in getting together the apparatus for the work, nearly all of these have been measured and tested, with the results exhibited in the tables presented farther on.

In the study of our tables of results it will be manifest, however, that not every fleece in the exhibits is represented among the samples we were able to collect. But it will doubtless be admitted that a fairly representative collection was taken. The difficulties surrounding the gathering of such collections in the usually crowded condition of an exposition, and even the training of persons for the work with the short notice for it that was given were too great to make perfection in this particular possible. In such case most careful preliminary preparation is necessary and perfect provision for all contingencies should be made long in advance.

While some exhibitors may consider omission of samples from their fleeces a matter of neglect, they should bear in mind the conditions prevailing at the time at which the samples were taken, and believe that an earnest endeavor was made to gather everything that was available. Furthermore, it must not be forgotten that in very many cases fleeces were not opened by the judges, because the information called for by the regulations was not furnished with them, and they were not therefore admitted to competition for award. In such cases naturally the wool handlers who took the samples would have no opportunity to secure representatives of the fleeces.

The samples prepared and delivered at the Pratt Institute in the condition described were first carefully catalogued and the label records compared with the official records in order that the samples themselves might be readily identified. This done the samples were divided and a portion of each inclosed in a small box of manila cardboard, 3 by 4 inches by about $\frac{3}{4}$ inch thick. Upon the side of this box was inscribed all the information concerning the sample found upon the label inclosed within the larger box. The number of the sample and the origin of the fleece it represented was then inscribed upon the end of the box. When all the samples were thus divided and transferred, the small boxes with the samples were stored in drawers with the end bearing the numbers upward, samples from each country or State being grouped together and arranged in series in the order of their numbering. In this way the samples were easily found when needed for examination or for reference.

EXAMINATION OF THE MATERIAL.

Certainly with such a collection of material from such widely separate sources and of so many different qualities, a careful study of the minute structure, external and internal, and the general morphology of the several varieties of fiber would be of the greatest interest, but in view of the limited time and facilities available this was out of the question. The examination was therefore confined practically to those general qualities which principally influence the commercial value of the product, and included measurement of the length of the staple

in crimp, its fineness, its strength, and its elasticity, each one of these qualities and their combination being considered requisite to the proper estimate of ultimate value. The methods employed in each case were as follows:

MEASUREMENT OF LENGTH.

The object of the measurement of the length of the staple to obtain the result as we have stated was intended to determine the depth of the fleece rather than the actual length of the individual fibers. To take this measurement without stretching or removing the crimp, a small lock was taken from the sample, and without stretching more than was sufficient to make it generally straight it was laid upon a rule and the length covered recorded. For wools of the same grade the result so obtained furnished a suitable basis for comparison and classification.

MEASUREMENT OF FINENESS.

This operation, which involves a good deal of important detail, is carried on in the manner usual for such work, with the microscope. In the preparation of the material for this purpose the sample under test is taken from its case, a small tuft of the staple drawn from it, and a portion of this separated so that between 30 and 50 fibers are secured. This ultimate tuft is then divided throughout its length into equal portions about half an inch long. Then one of these sections from nearest the middle of the length of the staple is selected and mounted in Canada balsam upon a glass slip and the others are rejected. Mounts so prepared are made from each sample and to each slide is attached a label bearing the number of the sample, the breed and sex of the animal represented, and the name of the exhibitor. When thus prepared they are arranged in series in the boxes of a Pillsbury cabinet for preservation and ready reference.

For measurement of the fineness the fibers of each slide was placed upon the stage of the microscope, the fibers brought successively into the focus of the objective, and the width of the image of each measured by means of an eyepiece micrometer. The instrument was so arranged that when used with a one-eighth inch objective and the tube was properly drawn, ten divisions of the eyepiece micrometer corresponded exactly one-one thousandth inch, thus making record and reduction of the measurements simple and most convenient.

It is accepted that the selection of any one portion of a tuft of the staple taken for the fineness measurement may give a result which is not the true average of the sample. It can not be questioned that the proper mode of procedure would be to divide such a tuft into portions of two or three or more parts, mount each part separately, measure it, and deduce the average for the sample from the results of all the

measurements taken. But in this case such a plan would be impracticable. A great deal of time and patient work is required for the mounting and measuring of so many sections, and the brief period of about two and a half months at our disposal for the examination would not admit of it. A better plan might be to take one or more tufts from different parts of a sample, cut them into several sections of about half an inch in length, make thorough mixture of the sections, and take from the mixture portions for mounting on the slide. This however, would be surrounded with troublesome difficulties, and would also have its sources of error, which after all might be as great as could occur in the method we have used. Really the most satisfactory method consists in measuring different sections of the same tuft, which may be made up of smaller tufts taken from several portions of the sample.

In this connection it is interesting to note that the sanitary history, as it were, of the animal during the periods of growth of the fleece is fairly well recorded in the staple. Thus, if we take a tuft of fibers from a sample and cut it into twelve equal sections throughout its length, the average of the measurements for each section will frequently be found widely different. If, then, these averages may be compared with a carefully kept record of the physical condition of the animal, it will be found that variations from the average, or at least a lower average, will generally correspond with observed conditions of indisposition. Such depression of the diameter of the fiber is particularly marked as a result of fevered condition following exposure to cold, wet weather, and with this reduction of cross section of the fiber there is naturally reduction of the strength of the fiber in the same part. Strong, vigorous constitution and continued good health tend to the production of even, strong staple and a larger fiber than can be obtained with poor constitution, poor food, or deficient care. The fineness of the fiber in its different parts may therefore become a register of the health of the animal, and from measurements taken in the manner described it is frequently easily possible to compute the date of any illness or indisposition the animal may have suffered throughout the year. It also illustrates the importance of giving to wool-producing flocks the best care and management and protection from exposure that is practicable. It also shows the advantages of sections of equable and temperate climate for the industry of wool production.

The medium in which the fiber is to be mounted for measurement of its fineness is most important. After considerable experience in this matter we have selected for the purpose Canada balsam, and there are several reasons for this. It is in most convenient condition for it. In the liquid condition a drop of it may easily be transferred to the slide and the small tuft of fibers laid upon it. After the thin cover glass has been put in place over the whole and lightly pressed

down, the slide may be heated sufficiently to evaporate all or nearly all of the solvent when, upon cooling, the balsam becomes perfectly hard, leaving the slide in most excellent condition for preservation. It readily dissolves the grease of the staple, so that this grease may not impair the condition of the mount or interfere with the perfect outline of the image in the microscope. It apparently penetrates the fiber, and, having nearly the same index of refraction, it renders the fiber very transparent, so that it is possible to bring into focus of the microscope without difficulty the longest diameter of the fiber. And above all, notwithstanding the fact that it apparently penetrates the material of the fiber, it produces no enlargement or swelling thereof, nor does it in any degree cause contraction. The fibers may easily be brought into focus, therefore, and accurate measurements easily taken when this medium is used for mounting.

But for purposes other than the mere measurement of the fineness of the fiber, it is by no means a desirable mounting material. It is almost impossible, on account of the transparency it produces, to bring out the fine differences of structure and the form and dimensions of the scales upon the surface of the fiber which seem so prominent when other mounting media are employed. For these latter purposes we have found glycerin jelly to be greatly preferable and to meet almost every demand. Yet this has a tendency to swell the fibers, and fineness measurements made upon slides prepared with it are surely unreliable. Slides prepared with balsam may be preserved almost indefinitely, and are always ready for reference or remeasurement.

When the slide has been prepared as described for each sample and properly labeled, it is placed upon the stage of the microscope, brought into the focus of a one-eighth-inch objective, the width of the image measured by means of the eyepiece micrometer, which has been standardized with a stage micrometer, and the result recorded. In this way measures of the width of the image of 25 fibers is taken for each sample, the average of all these measurements determined and recorded. The result is stated in thousandths of an inch, and thus, by means of the table for the purpose given in report upon an investigation of wool and other animal fibers, reduced to centimillimeters and the vulgar fraction of an inch. Such reductions have seemed necessary in order to make the result thoroughly familiar, and therefore intelligible, to all to whom the results may come.

It is possible that for some samples a good average could be obtained with a smaller number of measurements, but our experience has been that in order to have fair averages for all samples, at least this number should be taken. A little consideration will show that this work has involved taking at least 50,000 observations with the microscope.

It is conceded that, for the purposes for which these measurements were made, the use of the microscope after the manner we have

described is not the best means for the determination of the fineness of the staple. It has been repeatedly shown and is well known that the fiber is rarely if ever perfectly cylindrical, and that its right cross section is frequently rather an ellipse than a circle. In the measurement of the width of the image of the fiber mounted on a slide we may take the length of the longer diameter or the shorter according to the position that may have been taken by the fiber in mounting. The average results of the measurements would, therefore, be above or below the truth as presentation of either of these diameters predominated. From all the experience we have had it seems that a much better way to measure the fineness, when time and means are available, consists in mounting a tuft of the staple in some suitable supporting material and making, by means of a section-cutting instrument, cross sections of the tuft and its fibers perpendicular to their length. These sections, freed by proper solvents from the supporting material, should then be mounted in balsam or other medium on the glass slide used for support in microscopic examination. If, now, the tube of the instrument be turned to the horizontal position and the sections be brought into the focus of a good objective, their images may be projected by means of a strong light, either from the sun or the electric arc upon a screen, or with a suitable reflector be thrown upon a table. Here the outlines of the image may be traced for preservation upon paper, or it may be traced upon a sheet of tin foil laid upon the table. If the tracing be done with a needle or other sharp instrument the foil may be cut through and patterns of the image so cut out. Now, if the tin foil has been rolled to perfectly uniform thickness, the requisite number of patterns so made from different sections from the same tuft may be weighed and the weight compared with that of a quantity of tin foil of the same thickness and of known area. By this means, from the weight of the patterns taken the exact area of cross section of the fibers may be measured and the correct average for the sample so determined. It would yield a result of almost absolute accuracy and leave no room for question or doubt concerning it.

It is true that such a method would require greater time and labor than that needed for measurements with the microscope in the usual way, and that the expense otherwise attending it would be also greater, but the greater accuracy secured would be commensurate with it all. It is particularly important that this cross section should be determined with accuracy in order to compare the ultimate tensile strength of the fibers as shown by the tests with the dynamometer. Slight variations in the fineness cause larger variations in the ultimate resistance when computed to pounds per square inch of cross section and to the modulus of elasticity. And as the economic value depends so largely upon these standards, it is easy to see how important the careful and accurate measurement of the fineness becomes.

On this occasion the examination of the material was almost purely emergency work. It was the very earnest desire of the authorities that it should be completed and reported upon before the close of the Exposition. But this, for many reasons, was a practical impossibility. Still, the urgency was such that the old methods were perforce resorted to, and the results we have to offer were so obtained. It is to be hoped that the study of the wools of the world may some time be so provided for that the most improved means available may be used and results of the highest accuracy obtained. However, the results obtained at this time will be found of great value in the comparative study of the wools of this Exposition, and they will be found to be sufficiently near the truth to serve the practical purposes of the breeders or the manufacturers, and the methods followed are so simple that they may be used by even the most inexperienced in microscopic work. We can not refrain from expressing the belief that the application of this method of studying wool by the breeders in the selection of studs would do much to increase the value as to fineness of the wool produced.

MEASUREMENT OF STRENGTH AND ELASTICITY.

The commercial value of wool and its usefulness, both for manufacture and as textile material, is so closely allied with its strength and elasticity that the consideration of these qualities becomes of the highest importance. Except for certain limited uses, small variations of fineness are unimportant, but in all cases in which the best and most durable fabrics are desired the qualities we have now to consider are of the first importance, and as differences in these qualities in a good product and a bad product are so comparatively wide, they have peculiar significance in the classification of the staple for commercial purposes. Their measurement requires no little skill and a great deal of patience, for it involves the test of separate and individual fibers, and in order to secure a proper average for each sample a large number of fibers must be tested.

On this occasion there was practically no opportunity for choice of instruments with which to make these tests. A goodly number have been devised and some of those lately developed, while more or less complicated both in construction and operation, are nevertheless most convenient, both because of the accuracy of the results obtained with them and because of the provisions made for their automatic operation and registration. But these instruments are costly, and their construction requires so much time that it was impracticable for us to consider their use for the present work. Fortunately the instruments used in the work which furnished the results for the Report of an Investigation of Wool and Other Animal Fibers, published under the direction of the United States Department of Agriculture, were still in existence and available for the purpose, although some-

what out of repair. A complete description of them may be found in the report just mentioned, but for the benefit of those to whom this report may come and who may not be acquainted with the instrument and may not have access to that report, a transcript of the description therein given is offered here.

Many good authorities on strength of materials and the measurement of weights and strains in general maintain that satisfactory results can be obtained only when a beam balance is used, and it is upon this principle that the construction of the instrument we have employed is based. To arrive at this as nearly as possible we have made use of a pendulum attached to the shaft of a pulley free to turn. The power producing strain upon the fiber is transmitted to the periphery of the pulley and the pendulum moved from the vertical by the turning or revolution of the pulley furnishing the resistance. The construction of the instrument is indicated in the adjoining illustration. A is a standard for supporting the pulley B, to the shaft of which is attached the pendulum arm C bearing near its lower or free extremity the small weight or counterpoise D. At the point E in the periphery of the pulley is attached the end of the chain F, which passes over the periphery and in a groove provided, and at its other extremity is attached to the frame G, in the middle of the head of which and to the end of the chain is fixed the small clamp H. Now it is plain that any power applied vertically downward at the clamp H must be communicated to the periphery of the pully B, causing it to revolve and so move the pendulum from the vertical position. The deviation of the pendulum from the vertical, or the distance which its point moves over the arc I K, will be in direct relation with the power applied. To standardize the instrument and graduate it—for this must, of course, be done by experiment—it is only necessary to apply successively at the point H weights of different denominations and locate the point on the arc at which the point of the pendulum comes to rest after the oscillations communicated by the application of the weight, or started by hand, cease. As might naturally be expected, the divisions of the arc corresponding with different weights vary with their position; that is, they are smaller near the end I and gradually increase toward the end K. But there is a section in the quadrant where sines and cosines are nearly equal, and to secure as nearly as possible uniformity in the length of the division of the scale, an endeavor was made to confine the motion for the majority of the tests to that part of the arc. The pendulum was therefore so counterpoised by an initial weight that when in equilibrium it hangs at an inclination from the vertical line passing through its center of motion.

In the instrument we have used, which for convenience was graduated according to the metric system, the range given is 80 grams; but this range is necessary only in tests of the coarser wools, though in

our later tests samples were found for which this range was too small. The instrument with this large range is less delicate for tests of the finer and weaker wools than one of shorter range as regards weight, and in order to secure both conditions in the same instrument the following plan was adopted: The weight, or counterpoise D, was made detachable, and when it was removed the scale upon the upper edge of the arc was graduated in the same manner as the other. With the counterpoise thus removed, the shorter scale may be used for testing the finer fibers, and the arrangement makes the same instrument adapted to the test of fibers of widely differing strength and has proved exceedingly convenient on several occasions. The divisions of the arc representing grams are sufficiently large for the eye to detect and read off differences of a quarter of a gram and even less, though the scale is not so graduated. The other essential parts of the instrument are the following: The clamp L, entirely independent of the frame G, attached to the Rod *m*, which slides vertically through the hollow Screw *n*, works through the nut friction pulley, which in turn is in contact with the wheel or pulley Q, having the crank R for application of motion. The guides S S insure steadiness of the parts in operation. In practice the fibers to be tested are held between the clamps H and L, which are opened and closed by means of the thumbscrews shown. Originally these clamps were made of brass or composition metal, but long experience has shown that this metal is wholly unsuited to it and is too soft. The wool fibers repeatedly compressed between the clamps produce grooves in the metal, and finally to such an extent that the clamps must be renewed. It was our practice to dismount the clamps when this condition had been produced and to bring the surfaces to a smooth polish by means of a whetstone. This, however, is very tedious and troublesome. Finally, it was concluded to go to the other extreme and have the clamps made of the hardest steel, and this proved to be just what was needed. Those made for our latest work served admirably, and after 25,000 tests have shown no sign of wear. Indeed they have been most satisfactory, for they showed no tendency to cut the fiber as in the case of the composition-metal clamps, but they held the fiber to be tested most firmly and slipping, so common in the old clamps, was absolutely avoided. We are therefore convinced that no metal will serve this purpose so well as thoroughly hardened steel.

It is plain that if upon the application of power, which may be effected by turning the larger friction wheel or pulley Q, if the fiber be perfectly rigid, the distance between the clamps H and L will always remain the same until rupture of the fiber occurs, but in case of stretch of the fiber previous to rupture the distance between the clamps must be correspondingly increased and the measurement of this increase, and consequently the elongation, or ductility, or elasticity,

of the fiber provided for. A scale is ruled upon the frame G, while the indicator T passing over it indicates the amount of increase of distance between the clamps, and consequently of the stretch of the fiber. The initial distance between the clamps being fixed, the indicator is brought to zero of the scale by sliding along the rod M and finally fastened with its thumbscrew. The sliding rod is held in position by the thumbscrew M.

In the construction of the frame bearing the scale for measurement it is important that the sides should be able to swing freely in the direction of the opening of the clamps, for since the fiber can not always be placed in the upper clamp and directly in the central line of motion, the frame must, upon the application of power, if all the parts are rigid, be moved from the vertical position and there must consequently be a loss of power. But if the sides are made free to swing they readily maintain their vertical position whatever may be the position of the fiber in the clamps. The ends of the shaft of the wheel B are pointed and rest in conical bearings, this construction having been found to reduce friction to a minimum and make the instrument approximate more closely to the balance with hard bearings and knife-edge supports. The surfaces of the friction pulleys may be covered with rubber or other similar material to avoid noise and jarring but this was found not to be really necessary and for our present work was not used.

The combined instrument is mounted upon a substantial table, supported by leveling screws X and provided with the necessary spirit level, so that when in operation the pendulum may hang and swing in a vertical plane. The screw motion for application of power insures perfect steadiness and freedom from jerks, so that the strain may be increased slowly and with great regularity.

Originally the instruments were provided with stop arrangements to catch the wheel and hold the parts at the points reached at the instant of rupture. But experience showed that all such as could be applied simply and without great expense would not operate quickly enough, and in the actual tests it was necessary for the operator to watch the end of the pendulum in its motion over the scale and note the point at which rupture occurs. Then holding the pendulum at this point the stretch suffered by the fiber in millimeters read from the scale and recorded.

In making the tests, practically the following procedure is employed: First, the clamps are brought into position at proper distance from each other as determined by the coincidence of the indicator T with the zero of the scale on the frame G, the indicator having been previously properly set. The fiber to be tested is grasped by one end and inserted between the jaws of the upper clamp H and the latter closed by means of the small thumbscrew provided for the purpose.

The remaining free end of the fiber is drawn through the lower clamp L and fixed, the operator being careful to apply no more strain than is just sufficient to overcome the crimp and make the fiber straight. With the fiber thus fixed the wheel Q is slowly turned and power applied to the fiber through the screw motion and the standard M. Considerable practice is required to enable the operator to apply the power with proper rapidity. If the application be made too rapidly the result for strain is likely to be too high and that for stretch too low: As a rule, it has been found better to move along regularly and tolerably rapidly until considerable elongation has been produced and then to proceed only just fast enough to prevent the pendulum from receding on account of the stretch. The pendulum is constantly watched, the point upon the scale it has reached at the instant of rupture noted and finally recorded, the pendulum again raised to that point and the stretch suffered by the fiber under the strain read from the scale on the frame G and entered upon the record. One arm of the frame being graduated to millimeters and the other to parts of an inch, it is possible to state the result in either standard. In the present work we have used the metric scale.

This method has been employed in the tests for this work, and it has been found very satisfactory. The length of fiber tested has been uniform for all varieties, and has been the same as that adopted in our former work, which we have found no good reason to depart from, namely, 20 millimeters. This is a convenient length for all the wools tested, particularly for the fine wools which largely predominate among the samples collected at this time. The results secured with this length will not vary greatly from the average for different lengths in the same sample, being rather higher than those for greater lengths, especially in the matter of stretch. It is interesting to note that as the length subjected to strain increases the percentage of stretch decreases, and this decline is common to all varieties. The length adopted has been used for all the samples tested, and this uniformity makes all the results fairly comparable.

Former experience also determined that in order to secure good averages it is necessary to test at least 30 fibres in each sample. Greater accuracy would doubtless be secured by testing 50 fibers, and on some accounts it would be better to do so, especially when different samples are to be tested by different operators. The matter of personal equation in operating the instrument and observing the result, in taking the fibers to be tested, the inequalities in the individual fibers, all these have a tendency to produce variations in the results and to impair the accuracy of the average. But the variations occurring in averages secured by several series of tests upon the same sample are so comparatively slight that for practical purposes they may be rejected. In practice for this work, therefore, the 30 tests were

recorded and the averages determined from them. These being expressed respectively in grams and millimeters are converted into grains for strain, and into percentages of length tested (20 millimeters) for stretch. The averages are entered in the final record.

The inequalities in the individual fibers are frequently sources of embarrassment in securing perfect averages for the samples. If wool is defective it is generally so at some certain portion of its length and not throughout. It is very sensitive in growth and suffers greatly from any indisposition or delicate health in the animal producing it. If, for instance, a flock of sheep is exposed to inclement or rough, cold, wet weather, and the animals suffer in consequence, the wool produced during the pendency of such suffering will have a smaller average cross section and a lower strength. It so happens that in the examination of wool by commercial methods the tuft taken will show such weakness at a given portion of the length, which portion will correspond with the growth during a period of indisposition and the fleece will be, perhaps justly, condemned. At the same time the remaining length of the staple may be in perfect condition and of high quality. Such conditions are to be found in flocks bred and fed in sections of sudden changes of climate, where food and care are variable. An improvement in the method of testing such wools to secure a proper average might be made by testing the same fiber in several parts of its length, adopting the average of all the tests that may be made as the true average for the sample. This, time permitting, could be managed well enough with the longer and coarser wools, but it would not always serve or be practicable in the course of examination of the shorter merino wools. But with these the defects spoken of would doubtless occur within the limits that would be subject to the test in the instrument and the difficulty thus be automatically obviated. In the long wools, too, the same end might be attained by taking care to test in each sample different fibers in different parts of their length. For instance, in fibers several inches long one or several fibers should be tested nearer the butt or skin end, others nearer the middle, and others again nearer the tip. Thus the results of tests of thirty fibers of the sample would yield a good average for the sample. If this does not give sufficient indication of the special weakness occurring, the difficulty may easily be met by adapting special methods to special samples, and in the end a true estimate of the value of a sample will be arrived at.

Another precaution to be observed is to see that fibers for the tests are taken from every part of the sample and not from a single tuft. It is a common temptation to the operator to take a small tuft from which to take the individual fibers, but experience has shown that the quality of the wool may vary considerable from one part to another not far removed. So, then, instead of taking a small portion of the sample to the instrument for the test, it is much better to take the entire sample,

and, spreading it alongside, draw fibers from one part or another until the proper number has been tested. The characteristics of the fleece will thus be better brought out and the valuation of the quality be more satisfactory.

STATEMENT OF THE RESULTS.

As may be gathered from what has preceded, the number of actual observations made in this work has been enormous, and the individual results are full of interest and value for detailed study in connection with the history of the material they represent. They are too numerous, however, for this report, and we must be content with a presentation of the averages deduced from them and the data developed from these averages by computation. What we have to present now will serve the immediate purposes for which this examination was designed and provided, but the details have been preserved for future reference and will be at the disposition of anyone desiring to devote to them the study necessary to the development of the relations to be found in them.

After careful consideration it has been decided that it will be better to avoid making a separate catalogue of the samples taken, since, for the most part, the information given with the fleeces was limited, and what is offered is stated in such a way that it could be easily included in the tabular statement of the results. We have therefore included in our tables all the information required by the Exposition authorities from the exhibitors and furnished by them. They include the following: Name and address of the exhibitor; breed, sex, age, and live weight of the animal represented; the weight of the fleece. These have all been entered on the same line, under appropriate headings, with the results of our own observations and the figures deduced from them. The days of growth of the fleece was omitted, but the weight of the fleece and the observed length of the staple in crimp were as far as possible reduced to the equivalents of 365 days' growth. This, perhaps, is not altogether just, for it is a fact that animals sheared twice in a year do not yield as much wool as those sheared only once, and it is therefore possible that the rate of growth of wool is not uniform throughout the year. Still, some means for bringing the data offered to a standard that would serve for comparisons were needed, and this seemed the best that could be devised for the present.

Entering all the information available concerning a given fleece in the same place is more convenient for study of the relations exhibited than could be possible by having a catalogue separate from the results of the tests and computations. It was our original plan to enter in this table the results for each breed or grade together in groups to further facilitate study and comparisons, but the time at disposal and the large amount of clerical work involved rendered this impossible.

It is hoped, however, that it will not seriously interfere with the ready understanding of the tables, and that they may lead to the development of facts of value to both breeders and wool producers.

The results of all observations are stated in the averages. Fineness measurements were taken by a scale graduated in thousandths of an inch, but our correspondence with wool growers and wool handlers in different parts of the world has shown such diversity in the standards used that it has been considered better to express the fineness in accordance with all the standards, and so add to the clearness and the convenience of the tables to all concerned. We therefore express it simultaneously in centimillimeters, thousandths of an inch, and vulgar fractions of an inch.

The strength was observed in grams, and the stretch in millimeters for a length of 20 millimeters tested. The averages of the results were entered in the table, but for the sake of further clearness the averages were likewise expressed in grams for strength, and in per cent of length tested for stretch previous to rupture. But to make the results serviceable for proper comparisons, it was desirable to reduce these results, as in previous work, to equivalent for equal cross sections. For such comparisons of the samples among themselves a uniform diameter of 4 centimillimeters was arbitrarily selected, and for comparisons of the animal fibers with other materials an area of cross section equal to 1 square inch was selected. The new strain, or strength corresponding with 4 centimillimeters, is represented by S in the table, and the strength or resistance corresponding with 1 inch of cross section by R. The percentage of stretch may be represented by P. The modulus of elasticity, or the ratio between the resistance at rupture in pounds per square inch of cross section, and the percentage of stretch at rupture constitutes the modulus of elasticity, and is represented by $E=\frac{R}{P}$. This latter ratio serves for comparison of the samples with each other as regards the capacity of the staple to resist wear or destruction, either in the process of manufacture or in use as fabric. These results are arrived at in the following manner:

The "ultimate tenacity" or "resistance" determines the strength of the staple, and in the results secured in each test with the dynamometer it seems to vary widely from fiber to fiber and from sample to sample, and comparison between them becomes possible only when fibers compared happen to have the same diameter. It becomes necessary to reduce the results of specific tests to figures which correspond to strains for samples having a common diameter, and this diameter we have assumed to be 4 centimillimeters. The formula for the reduction is made as follows:

Let 4 centimillimeter=D′, the assumed common diameter.

Let D=the average diameter of the fiber for the sample.

Let S=the average actual tensile strain necessary to rupture.

Let S′=the tensile strain necessary to rupture of a similar fiber with a diameter of 4 centimillimeters.

Then, since the strains will be to each other as the squares of the diameters of the corresponding fibers, we have the proportion,

$$D^2 : (D')^2 :: S : S'$$

$$\text{and } S = \frac{(D')^2 S}{D^2}, \text{ or } \frac{16 S}{D^2}.$$

This affords a means for the direct comparison of each sample as regards the ultimate resistance to rupture. It is expressed in grams for an area having a diameter of 4 centimillimeters, but to very many it will be more readily comprehended if expressed in corresponding pounds per square inch of cross section, and this value is obtained as follows:

Using the same letters for the respective values as above we have $\frac{\pi D^2}{4}$ = the sectional area of the fiber in square centimillimeters.

Since 1 square millimeter contains 10,000 square centimillimeters, 1 gram per square centimillimeter will be equivalent to 1,000 grams or 10 kilogrammes per square millimeter.

And since 1 kilogramme per square millimeter = 1422.30786 pounds per square inch, 1 gram per square centimillimeter = 14223.0786 pounds per square inch of cross section of fiber.

The general formula for this reduction then becomes $\frac{4 S}{\pi D^2} \times 14222. = 18109 \frac{S}{D^2} =$ R = the ultimate resistance in pounds per square inch.

The results obtained by this formula may be usefully employed in making comparisons of a certain class in which the elasticity of the fiber need not be taken into account. But in a material the value of which depends so much upon this quality it can not be ignored. This relation is expressed in the modulus of elasticity or the ratio between the ultimate resistance and the percentage of stretch suffered under the corresponding strain. This may be found as follows:

Let E = the modulus of elasticity for the sample.

Let R = the average tensile resistance in pounds per square inch = $18109 \frac{S}{D^2}$.

Let P = the per cent of stretch expressed in decimal form.

Then the general formula becomes $E = \frac{R}{P}$.

Applying the values obtained from the tests made, the computations necessary to the determination of the data given in our tables were made. It is believed that the tables will further explain themselves, and will make it possible for each one to determine for himself the superiority of any fleece exhibited over any other fleece exhibited and represented here.

MATERIAL EXHIBITED.

It must be admitted by all interested in or acquainted with the wool, producing industry of the United States that the exhibit of wool from this country presented in the Columbian Exposition was totally inade-

quate to represent the condition or the position of the industry at the present time. States which send enormous quantities of the staple to the markets, and which almost even control the market prices, are not to be found in the rôle of exhibitors at all. And even the States that were represented failed to enter into the matter with the earnest zeal necessary to successful exhibition, and most of them furnished collections entirely too limited to fairly indicate the progress made or the standard of the product obtained. The two States of Wisconsin and Ohio furnished almost half of the wool exhibited from this country, while the most of the States west of the Mississippi, from which the markets largely draw for supplies, were conspicuously absent. The States of Vermont, New York, Pennsylvania, and West Virginia, upon the stud flocks of which not only other States of this country, but all the sheep-growing countries of the world, draw for the blood for improving the condition of the wool-producing flocks, showed collections which, while containing some good examples, were by no means up to the standard of those shown in earlier expositions, nor, it is believed, fairly illustrating the high state of development attained in the production of large bodies, strong, hardy frames, long staple and heavy fleeces, combined with satisfactory and even great fineness of fiber. That the sheep breeders should have been so blind to their best interests is surprising, and it is scarcely characteristic of the energy and enterprise of native American producers.

It will be difficult here to undertake any extended statement of the condition of sheep breeding and woolgrowing in the different States of the country, for in the conditions in which the judges were placed satisfactory information with this regard was not obtainable in the Exposition. Such information is, however, available in the publications of the State agricultural boards and departments, and to such we must refer those desiring it. But it is likely that the exhibits made in Chicago are, in a measure, an indication of the tendencies in wool production in the several States named, and a brief review of the general character of the exhibits from each of the States may be of interest.

Of greater interest to American breeders and woolgrowers will be the study of the character of the exhibits from other countries, and these are worthy of the most serious consideration. The great competitors in the wool markets of the world are the colonies of Great Britain and the Republics of South America, and certainly the highest credit is due to the energy, skill, and intelligence shown in the collections presented by the Australian colonies, the Cape Colony, and the Argentine Republic and Uruguay. It is unfortunate that so important producers of wools as South Australia, Queensland, Tasmania, and Adelaide were absent from this great exhibition of the world's products, yet American producers may find in what was offered much material

for profitable study, and it is to be hoped they will take advantage of it.

The collection of foreign wools finding their way to the markets of this country prepared and exhibited by Mr. Carl Grubnau, of Philadelphia was most unique and full of interest. The enterprise and public spirit which prompted this presentation of the wide range of animal fibers is most commendable, and it added greatly to the educational value of the exhibits in this class.

FOREIGN WOOLS.

NEW SOUTH WALES.

Of wools not produced within the United States exhibited in the World's Columbian Exhibition, by far the largest collections were sent from the colonies of Great Britain, and, while some of these were conspicuously absent from the collection, those represented showed remarkable skill, both in the selection and presentation of the material exhibited. Among these the exhibit made by New South Wales is to be particularly commended, not only on account of the high quality of the wool, but for the attractive manner in which it was exposed to visitors, the systematic description offered in the carefully prepared catalogue, and pamphlets of information concerning it and sheep and wool growing in the colony in general.

The wools from these English colonies were, almost all of them, of the fine-wool or merino type, and if we were to judge from the exhibits alone we should be led to conclude that these colonies were devoted wholly and exclusively to wools of this type. It is true that they constitute the large proportion of the product, but we learn from the most interesting and valuable little pamphlet, entitled Sheep and Wool in New South Wales, which accompanied and really formed a part of the exhibit, that in later years a very considerable infusion of long-wool blood to the flocks has taken place and that a good deal of the wool now sent to the markets consists of either pure long wool or of wool from crosses of the Merino with the long-wool races. So we learn that the breeds predominating are the Merino, Lincoln, Leicester, Downs, and Romney Marsh, together with crosses of the long-wool breed, principally with the Merino. At the close of 1891 the respective numbers of Merino and long-wooled sheep and crossbreeds stood thus:

Merino	60,252,458
Long-wooled sheep	641,152
Crossbreeds	937,806
Total	61,831,416

The flocks of New South Wales represent nearly half the wool-producing capacity of Australia, as is shown by the following table

from the same source, giving the number of sheep in each colony at the close of 1891:

Colony.	Number of sheep.	Per cent of total area of Australasia in each colony.
New South Wales	61,831,416	49.7
Victoria	12,928,148	10.4
Queensland	20,289,633	16.3
South Australia	7,646,239	6.1
Western Australia	1,962,212	1.6
Tasmania	1,664,118	1.3
New Zealand	18,128,186	14.6
Total for Australasia	124,449,952	100.0

The Annual Review of the Victorian Wool and Grain Markets 1891–92, published by the New Zealand Loan and Mercantile Company, gives the following figures for the number of bales of wool shipped from Australasia from June 30, 1891, to February 29, 1892:

New South Wales	533,000
Victoria	418,407
Queensland	147,276
South Australia	153,485
Western Australia	14,805
Tasmania	24,151
New Zealand	220,098
Total	1,511,222

The total shipments for the year ending February 29, 1892, equal 1,812,695 bales. This does not include a not inconsiderable quantity of the product retained for home consumption and manufacture.

The authority first quoted states that—

The different degrees of success attending sheep farming in different parts of the country have long since directed attention to the fact that each part of Australia is not equally fitted for the production of fine wools. New South Wales may be divided climatically into four zones: (1) The coast country, extending from the seaboard to the main range, the breadth of which varies from 20 to 100 miles; (2) the table-land districts on the summit of the range; (3) the upper part of the western slopes; and (4) the interior or "salt-bush country."

The climate of the eastern seaboard for a considerable distance inland is too moist and a large portion of it is too poor for the adequate sustenance of Merinos, but it is probable that the coarser breeds of sheep would not deteriorate through the limited food supply and the rugged nature of the country. On the Hunter and Northern rivers and in the southern coast districts, where the soil is very rich, dairy farming and agriculture are the leading, and no doubt the most profitable, industries. Sheep breeding is carried on to some extent in the regions toward the summit of the coast range, but, as in the case of the country near the sea, the soil as a rule is unfavorable to sheep. On crossing the coast range, however, the contrast between the aspect of the country just entered and that left behind is very striking. Here the grazing and wool-growing capacities are at once apparent, and farther westward still a greater improvement is visible.

In the abundant pastures of the river districts the wool is less fine than in the country immediately west of the table-lands, but the fleeces are generally sound and heavy. Farther in the salt-bush country the wool suffers both in weight of fleece and in its quality, but the country is fattening and the stock are generally more healthy than those nearer the sea. In the country on the farther side of the Darling the great summer heat is adverse to the production of heavy fleeces, but even here a fair class of wool is produced, as the stock owners are constantly introducing fresh blood, and so counteracting the tendency toward the degeneration of the breed of sheep which might otherwise ensue.

The experience earned in Australia in the matter of selection of proper altitudes and climate for sheep breeding for wool production is important, interesting, and significant. They should be borne in mind by the wool growers and those interested in the woolen industries in the United States. There is no doubt that too little attention is given to such influences as have just been described, and that many of the failures that have followed the enterprise of some growers in this line may be traced to the climatic conditions of the section chosen for the work.

The authority just quoted further says:

Sheepbreeding was about this period (1823 to 1825) commenced in the Mudgee district, and the climate of that region has produced still more favorable result upon the quality of the fleeces than any other part of the colony, and it is thence that the finest Merinos are now produced. * * * As might be anticipated, the climate of Australia has in some respects changed the character of the Spanish fleece. The wool has become softer and more elastic, and, while having diminished in density, it has increased in length, so that the weight of the fleece has only slightly altered. The quality of the wool has thus, on the whole, improved under the beneficial influence of the climate, and if no further enhancement in its value can be reasonably hoped for, there is at least every reason to believe that the Australasian will maintain its present high standard of excellence.

And further:

The climate of New South Wales admits of stock of all kinds being left in the open air, and there is no necessity for housing them during the winter months. The sheep are either kept in paddocks or under the care of shepherds, though on some stations they are both shepherded and paddocked. During 1891 there were—

Paddocked	60,127,284
Shepherded	917,321
Paddocked and shepherded	786,811
Total	61,831,416

The advantages of the paddocking system are now universally acknowledged. The country will carry one-third more sheep, the wool will be longer and sounder, and the fleece as a whole one-third better, the feed will be cleaner and less liable to grass seed, the lambing on the average of years will be better, the sheep will increase in size, they will live longer and continue longer profitable, they will be freer from foot rot and other diseases, the expense of working the station will be less than a quarter of what it would be if the sheep were shepherded, and, finally, the owner will be able to devote the principal part of his time to improving his sheep instead of spending it in attempting to manage a number of shepherds and hut keepers.

A table given in this connection shows that the percentage of lambs secured in paddocks is considerably greater than when the flocks are shepherded, in most cases by from 10 to 15 per cent. In 1891 the ratio was 69:63 and in 1885 79:64. Careful study of the very excellent tables describing the exhibits of wool in Chicago can not be too strongly recommended. It is a most valuable example of what should be done for this and every other wool-growing country for the advancement of the great industry of wool production. From this table we learn, besides what we have transcribed to our own tables in the matter of age and weight of animals represented in the fleeces and the weight of the fleece in each case, the elevation above sea level, and the nature of the soil on the estate on which each fleece or bale offered for exhibition was produced, the average summer and winter temperature of the same locality, and its average annual rainfall in inches. From this we learn that the elevation above the sea level of the sheep ranches varies from 300 to 4,000 feet. But nearly 60 per cent of the sheep are grown at elevations below 1,000 feet.

The weights of the fleeces exhibited, as may be seen upon consulting our tables, were high as compared with the average weights for the colony as shown in the table given in the pamphlet report already referred to. The majority of the sheep are sheared in grease, but some are still washed with hot water, and under a spout, or in the brooks, while some of the fleeces are scoured before being sent to market. The table referred to gives the average weight of fleece taken under each of these conditions and it will suffice for our purpose if we take the figures for the last five years named in the table:

Year.	Sheep.						Lambs.	
	In grease.		Creek washed.		Scoured.		In grease.	Washed.
	Lbs.	*oz.*	*Lbs.*	*oz.*	*Lbs.*	*oz.*	*Lbs.*	*oz.*
1887	5	9	3	1¼	2	14	1	12¼	1	5
1888	5	6¼	3	1¼	2	9¼	1	11	1	7
1889	5	13¼	3	3	2	14	1	11¼	1	9
1890	5	11¾	3	2	3	4¼	1	14¼	1	7¼
1891	5	9	2	14¼	3	7	1	15	1	4¼

Naturally the fleeces exhibited are all of them heavier than the averages given here, for these represent the averages returned from all flocks. The weights given in our table indicate that the fleeces range in weight from somewhere about 5 pounds as a minimum to 15 or 20 pounds as maxima, the most of the fleeces ranging at about 12 pounds in weight.

We learn both from these published sources and the data found in our own tables that there is a growing tendency in New South Wales, even as there is in this country, to get away from the Merinos having small frame, short staple, and light, fine fleeces, and to breed to animals

having larger, heavier frames, and denser, deeper, and heavier fleeces, but a less fine fiber. So we find animals ranging in weight and probably the larger number represented in the exhibits may belong to this class, weighing from 40 to 100 pounds, but there are others in very considerable numbers ranging in weight from 100 to 130 pounds, while a few, notably some from the Duntroon estate in the Upper Murrumbidgee district, have live weights ranging from 150 to as high as 233 pounds. Yet from these exceedingly large animals fleeces of from 9 to 15 pounds were obtained, those weighing 233 pounds giving only 9 pounds of wool. Such animals will, however, without doubt have an important and valuable influence upon the flocks of the colony in the direction of forming better frames upon which to produce wool, and better and stronger constitutions to withstand the vicissitudes to which large flocks must of necessity be subjected.

From another report prepared by the commissioners from New South Wales for the information of visitors we glean the following statistics showing the number of sheep in the different districts of the colony, the elevation of the districts above sea level, the average summer and winter temperatures, and the annual rainfall in each one. It must be admitted that the very equable climate of the colony has a marked influence upon the character of the staple, insuring evenness, softness, and high luster, and there is no doubt that the higher altitudes at which the larger proportions of the flocks are pastured also affect the quality of the product. Such relations as these must be worthy of the closest study and then detailed consideration should furnish results of the highest value to the growers of both this and other countries.

Wool district.	Number of sheep.	Elevation.	Temperature.		Average annual rainfall.
			Average summer.	Average winter.	
		Feet.	*Degrees.*	*Degrees.*	*Inches.*
Bathurst	2,979,550	1,000–3,000	66–73	42–45	24–33
Bogan	1,709,055	625	79.7	57.7	24.6
Castlereagh	4,076,196	400–1,000	77–85.6	55.4–57.4	31.3–33.3
Darling (Lower)	631,176	112	77.5	52.6	19.7
Darling (Upper)	4,808,672	350–680			
Darling (Western)	4,745,382	300–350	80–85.7	54.7–57.2	14–19.7
Goulburn	641,428	2,255–2,360	69.9	47.2	23.78
Gwydir	2,856,598	350–1,700	75.4–84.2	46.6–56.1	28–33.4
Hunter River	4,055,365	1,500–2,500	70.1	53.4	41.5
Lachlan	5,452,571	700–1,600	74–80	55–56	24–26
Liverpool Plains	4,055,365	850–3,000	74–77	46–56	37–49
Monaro	1,439,841	2,700–3,500	71.4	44.8	20.38
Mudgee	1,181,944	1,350–2,000	73–79	48–54	27.28–45
Namoi	3,909,830	420–770	74.5–82.3	52–58.2	32–37
New England	2,581,642	1,350–4,000	67–72	47–49	24–35
Murrumbidgee	5,099,381	743–2,500	69.8–80	47–49.6	24–30
Riverina	3,267,946	304–821	73–79	46–49	27–29
Riverina (Southern)	4,101,115	390–450	76	48	32

In addition to the general exhibit of fleeces and bales of wool the commission from New South Wales presented the following, which

were arranged in a most attractive manner, and were subjects of the most instructive study:

5480. Photographs of Australian wool stores, from the Australian Mortgage and Agency Company, Sidney.
5481. 12 photographs of New South Wales sheep, from the commissioners for New South Wales.
5482. 13 photographs of sheep and cattle stations of the colony. Commissioner for New South Wales.
5483. 2 photographs of wool rooms, from Dalgety & Co., Sidney.
5484. Photographs of the wool stores of New Zealand Loan and Mercantile Company, Sidney.
5485. Photograph of wool warehouse of the Goldsborough Mortgage Company, Sidney.
5486. Photograph of wool warehouse of Hell, Clark & Co., Sidney.
5487. Photograph of showroom, Wenchcombe, Casten & Co., Sidney.
5488. System of sheep brands and marks, Alen Rence, chief inspector, Sidney.
5489. Squatter's wool wagon and photographs of wool showroom, Henry Goodwin, Sidney. Type collections of Australian wools, prepared by the department of public instruction, Technological Museum, Sidney.
5723. Stud wools, No. 1, 13 fleeces.
5724. Commercial wools, 20 fleeces.
5425. Fine merino wools from stud sheep, 128 samples.
5726. Classification of wools as prepared on the stations, 76 samples. Samples of wool and prices of 1892–3 from wool brokers, Sidney.
5727. Superior clothing wools, 12 samples.
5728. Harrison, Jones & Devlin, 43 samples.
5729. New Zealand Loan and Mortgage Company, 28 fleeces.
5730. Dalgety & Co., 30 fleeces.
5731. John Bridge & Co., 35 fleeces.
5732. Winchcombe & Co., 38 fleeces.
5733. Australian Mortgage and Agency Company, 13 samples.
5734. J. H. Geddes & Co., 14 samples.
5735. Hell, Clark & Co., 14 samples.
5736. Greasy lamb's wool, 40 samples.

Altogether the exhibit of wool from New South Wales may serve as an excellent model to be followed and copied in future exhibitions, and the commissions from that country have reason to be proud of the success attending their efforts to make a clear exposition of the extent and the advancement of the wool-producing industry in their colony. Particular credit is due to Mr. Alexander Bruce, chief inspector of stock for New South Wales, to whom the presentation of the exhibits in this class was intrusted.

VICTORIA.

Lying so closely adjacent to New South Wales and so closely allied thereto in all interests, and particularly as regards the sheep and wool industry, it is natural that the wools sent from Victoria should be in many respects similar to those from the neighboring colony. The woolgrowers of Victoria were the sole representatives of the country in the exposition, and the exhibits in the class were prepared and exhib-

ited through the instrumentality of the Australian Sheep Breeders' Association. The wools were contributed by about a dozen growers, and are believed to fairly represent the product of the country in this line. They consist principally and almost exclusively of fleeces of the Merino type. With the exception of one bale of cross-bred Leicester, sent by Sir William Clarke, Bart., of Bolinda Vale, and 13 fleeces of Victoria Merino crossed with Vermont Merino, all the fleeces were pure Victorian Merino. The valuable influence of the introduction of the Vermont blood to the flocks is well illustrated in the exhibits of Joseph Mack, which show fleeces weighing nearly 19 pounds, with staple under 3 inches in length, while the average weight of all the fleeces exhibited is under 10 pounds. Such fleeces must of necessity be full and dense, and must cover the bodies completely and evenly. As a rule the wool is very fine, and has length in crimp corresponding with the Delaine types, over 3 inches, and not infrequently exceeding 4 inches.

Our own wool producers may profitably take example from these exhibits, also in the indications manifest with regard to the care and cleanliness in the management of the flocks which produced the wools here offered, and the manner in which the fleeces and bales were presented for exhibition. They were free from burrs and dirt of every kind, and were spread in cases in such a way as to show the several parts without the difficulty of the removal of ribbons and cutting and pulling of strings. Altogether the exhibits were a source of pleasant and profitable study.

NEW ZEALAND.

The exhibits of New Zealand in the class in which we are particularly interested were not as extensive as those from the other Australasian colonies of Great Britain, but they were fairly representative of the product of the country and of most excellent quality. It is unfortunate that more complete records concerning the exhibits were not at hand, and that at the time when the judges were ready for their examination no representative of the exhibitors was present to furnish the information required for intelligent work. The exhibits were exposed upon uncovered tables, and at the time of the examinations many of the labels of the fleeces were either misplaced or lost, causing no little confusion and difficulty in the matter of securing accurate and satisfactory samples. What we have secured, however, is sufficient to illustrate the character of the product of the colony and show the advanced stage of progress that has been attained in the improvement of the flocks.

The general characters of the wools are similar to those of the neighboring colonies of New South Wales and Victory, being produced under much similar conditions of climate, soil, and general

environment. We are indebted to Messrs. Parrott & Co., of San Francisco, for publications relative to the production of wool in New Zealand, and the soil, climate, and pasturage, from which we shall offer the following abstracts:

Wool is undoubtedly the most important production of New Zealand, its value in export approaching nearly treble that of gold. Wool is divided into two classes, combing and clothing. The first comprises the long staple wools of the Lincoln, Leicester, Cotswold, and Romney Marsh breeds of English sheep. This is a class of wool for which the soil and climate of New Zealand are very suitable. The long-wooled sheep of Great Britain improve by the change; the length of the wool is increased and all its valuable properties preserved, owing, doubtless, to the genial climate and absence of exposure to the extremes of an English temperature. The Leicester breed has received great attention in New Zealand and is the favorite with the Auckland sheep farmers.

The Cotswold wool is very similar to the Leicester, but of a somewhat deeper and harsher character, and lacks the luster so much in demand for certain classes of manufactured goods. The Cotswold appears quite as much in favor with the New Zealand breeder as the Leicester, and probably its habits and character are more generally adapted to the climate of the South Island and the mountain pastures of the colony than any other long-wooled sheep. The Cotswold bear exposure better than the Lincoln or Leicester, will live and thrive on poor land, and come to more weight of carcass than any other breed.

The value of this breed as a cross with either Leicester or short-wooled sheep can not be too much spoken of, and the favor in which crosses with the Cotswold are held is a sufficient proof of their excellence.

The Romney Marsh partakes in a measure of the qualities of the Leicester and Lincoln, being a soft, rich, and good-handling wool, rather finer in quality than the Leicester, and having the glossy "luster" appearance of the Lincoln. Wool of this description is much in demand for certain fabrics, and is much sought after in the French markets.

The Cheviot is a wool that has grown into considerable popularity of late years and is largely used in worsted manufacture. It is a small, fine-haired wool of medium length and moderate weight of fleece.

The second kind or clothing wool comprises the short-stapled wool grown by the Southdown and Shropshire Down breeds of English sheep and the Merino (Spanish) sheep.

The Southdown is a short-stapled, fine-haired, close-growing wool. The value of this breed to New England sheep farmers consists mainly in the improvements which crossing with it imparts to the carcass. Some breeders have crossed the Southdown with the Merino and with crossbred Romney Marsh and Merino.

The Shropshire Down is a breed which is growing every year into more importance. It produces wool longer in staple and more lustrous than any other Down breed. It has been cultivated in New Zealand to a small extent only.

The Merino is the most valuable and important breed cultivated in New Zealand, and of sheep of this class the flocks of the colony are chiefly composed. They are of the Australian Merino variety, improved through the importation of pure Saxon Merino rams from Germany. The excellence of the Merino consists in the unexampled fineness and felting property of its wool, which in the fineness and the number of serrations and curves exceeds that of any other sheep in the world. The Merinos adapt themselves to and thrive in every change of climate, and with common care retain all their fineness of wool as well under burning tropical sun as in cold mountain regions.

The home consumption of wool was, in 1888, 4,079,563 pounds, and the export in 1889, 102,227,354 pounds, worth £3,976,375.

The mildness of the winter season (which does not require that any special provision shall be made for keep of the stock during that period), the general suitability of the country for grazing purposes, and the production of a superior class of wool caused the attention of the first settlers to be much given to pastoral pursuits, so that at a very early date all grass lands were taken up as sheep or cattle runs. By improvements in fencing and sowing with English grasses, which thrive remarkably well in the colony, the bearing capabilities of the land were increased many fold. While in the North Island there are considerable tracts of grazing ground with natural herbage, a large extent of the country consists of hill land of varying quality, covered with forest, or bush, as it is called in the colony. This land, after the bush has been cut down and set fire to, if grass seed be sown upon the ashes, is converted in a few weeks into good grazing land. Much forest has already been destroyed in this manner and the land supports large flocks and herds.

In the South Island the bush is chiefly confined to the western slopes of the dividing range, the open hills, plains, and downs to the east of the range being available for grazing purposes. The extent to which pastoral pursuits have been followed may be estimated by the quantity of stock in the colony in 1886 (when the last census was taken, as follows: Horses, 187,382; cattle, 773,028; sheep, on May 31, 1890, 16,116,113. These numbers do not include animals in the possession of aboriginal natives. The Maoris were found to have possessed at the time of the census of 1886 at least 112,850 sheep, 42,103 cattle, 92,091 pigs, besides a number of horses of which no account was obtained.

CLIMATE.

The climate resembles that of Great Britain, but is more equable, the extremes of daily temperature only varying throughout the year by an average of 20°, while London is 7° colder than the north and 4° colder than the middle island of New Zealand. The mean annual temperature of the north island is 57° and of the middle island 52°, that of London and New York being 51°. The mean temperature for the different seasons for the whole colony is, in spring, 55°; in summer, 63°; in autumn, 57°, and in winter, 48°.

The climate of the west coast of both islands is more equable than on the east, the difference between the average summer and winter temperature being nearly 4° greater on the southeast portion of the North Island, and 7° on that of the Middle Island than on the northwest, on which the equatorial winds impinge. The constant wind is the most important feature in the meteorology of New Zealand, and is rendered more striking by comparing the annual fluctuation of temperature on the opposite seaboards of the South Island, which have a greater range of temperature by 18° at Christchurch on the east than at Hokitika on the west.

Mean annual rainfall.

North Island:	
Auckland	45.306
Taranake	58.084
Napier	37.260
Wellington	50.781
Middle Island:	
Hokitika	112.156
Christchurch	25.774
Duredin	32.019
Southland	43.674

The observations that have been taken show that the northern part of New Zealand is within the influence of the subtropical winter, rainfall in winter in that part of the colony being twice as large as in summer.

In the south, however, the rainfall, though irregular, is distributed more equally over the year. The chief difference to be observed is that on the west coast spring rains prevail, and summer rains on the east coast; while in the middle of the colony the driest season is autumn, and in the south it is the winter and spring.

The contrast between the rainfalls on the east and west coasts, as with the temperature, is most striking. Thus, in North Island, Napier on the east has only half the amount of rain that falls in Taranaki on the west. But Middle Island, with its longitudinal range of lofty mountains, exhibits this feature in a still more marked manner, for the rainfall on the west is nearly five times greater than on the east. The excess of precipitation on the coast is clearly illustrated by the distribution of the glaciers on the opposite side of the range. Those on the west slope have an excessive supply of snow, and descend to a line where the mean annual temperature is 50° F., while on the east slope they descend only to the mean annual temperature of 37°. The winter snow line on the southern Alps on the east side is 3,000 feet and that on the west side is 3,700 feet.

Periods of lasting drought are almost unknown in New Zealand, and only in two instances do the records show a whole month at any station without rain. The greatest day's rain recorded is 6½ inches at Auckland, and 9½ inches in Nelson. Similar heavy showers occur at the northwest stations, where the general average shows 70 inches in 85 days in the year. The opposite extreme is on the southwest, where 34 inches fell in 180 days.

The area in New Zealand sown with English grasses is 7,400,000 acres, of which about 1,100,000 acres belongs to Auckland. The sheep flocks of the colony increased from 16,753,752 on May 30, 1891, to 18,475,500 on May 30, 1892. Auckland claims 131,994 of this increment, and the total number of sheep in this province at the latter date was 460,601. These figures indicate very marked progress, and there is no doubt whatever that with favorable conditions the totals of next year, especially on North Island, will give further evidence of advancement. (Wool season of 1892–93, New Zealand Loan and Mercantile Agency Company.)

The total quantities of wool exported from New Zealand during the years 1890 to 1893 had the following values for each year: 1893, £3,774,738; 1892, £4,313,307; 1891, £4,129,686; 1890, £4,150,599.[a]

The following table[b] will illustrate the distribution of wool production in New Zealand. It shows the shipments of wool at various points from March 1, 1891, to February 29, 1892:

	Bales.
Moercargill	27,078
Dunedin	30,819
Omaru	15,172
Timaru	22,274
Christchurch and Lyttleton	57,530
Blenheim	8,004
Wellington	52,525
Napier	54,416
Gisborne	10,400
Auckland	14,404
Waganui	11,512
Total	304,134

[a] New Zealand Trade Review, February 22, 1894.

[b] Annual Review of the Christchurch wool and grain markets 1891–92.

The character of the wool produced in New Zealand, even as in other wool-producing countries of the world, is likely to undergo rapid and serious change in the coming years, due to the widely extending development of the frozen-meat trade everywhere springing up. The fine-wool Merinos have too small carcasses, and are so little adapted to laying on fat and so making good mutton that on account of this new industry they must give way in the sheep pastures to the larger bodied and longer and coarser wooled breeds. It is therefore probable that in the near future the Merino flocks will be replaced by the Downs and the sheep of the long-wooled type. The seriousness of this condition is illustrated in the following table, showing the shipments of mutton from different countries to England during 1891.[a]

	Number of carcasses.	Average weight of carcass.
		Pounds.
Australia	335,912	56
New Zealand	1,906,002	52
River Plate and Falkland Islands	1,127,453	44

THE CAPE COLONY.

The wools exhibited by the Cape Colony were a delight to the lovers of fine, strong, lustrous wool. Produced in a country of equable climate and excellent pasturage, and upon animals whose pedigree extends to some of the most celebrated flocks of Spain and Saxony, it is natural that these wools should take a high rank, for, from an interesting paper from one thoroughly conversant with the wool history of the colony, we learn that the present fine-wool flocks sprang, many of them, from the famous Electoral flocks of Saxony by importations in 1812, and from the celebrated and original Escurial flocks by importations in 1820. These flocks have been carefully guarded by the masters, have been improved by selection, and by the introduction of rams from Australia, France, and even the United States, until the product leaves almost nothing to be desired.

The area of wool production in the colony may be divided into two principal sections, the Karoo and the Grass Veldt, the former lying inland and to the northwest, with plentiful pasturage of the best quality, and the latter lying nearer the coast, to the east and north. Both these principal sections were represented in the Exposition, the Karoo Desert most extensively.

The woolgrowers of the colony showed most intelligent discrimination in the selection of fleeces for the Exposition, and it was rare to find among those exhibited any from animals over two years old, and most of them were from either ewes or wethers. This in large flocks is, how-

[a] Christchurch Review.

ever, to be expected. The fleeces were generally of light weight, varying from 5 to 10 pounds, some exceptions rising to 12 and 14 pounds. The wools are soft and elastic, with sufficient yolk and of most attractive quality, while their length makes them valuable for either clothing or fine combing uses.

The growth of the woolgrowing industry began in about 1820 with the importations of the Merino sheep from Spain. Constant increase has followed, and while it is stated that in 1830 the export of wool from the colony was only 30,000 pounds, it had grown in 1891 to 75,520,700 pounds.

Closely allied with woolgrowing in Cape Colony is the growth of Angora hair or mohair. From the articles of Mr. Mitchell we also learn that the Angora goats were first introduced from Turkey in 1854. Since that time repeated importations by others have been made from Asia Minor and elsewhere, until in 1891 the exportation of mohair reached very respectable proportions, amounting to 9,953,548 pounds. The flocks of Angora goats in the colony are now said to number 3,000,000, so that the average annual yield per head is about 3 pounds of hair.

While the wools of the merino type were the principal kind exhibited in Chicago, the sheep growing is not exclusively confined to this type. The other type grown in the Colony is the fat-tailed sheep of the eastern nations, and it is stated that the flocks of this breed contain at least 3,500,000 animals. Unlike their relatives in Turkey, Asia Minor, and Russia, they produce practically no wool, and the sheep are grown principally for their mutton, which is of excellent quality; for the skins, so serviceable for making glove leather, and particularly for the fat tails, which yield from 20 to 30 pounds of fat of quality greatly prized in different parts of the world, and which in those sections in which these sheep are grown serves as a substitute for butter. This breed has in some places been crossed with the Merino with good results; and it is stated that some of the breeders are accustomed to breeding the crosses for a few generations when the demand makes them more profitable, and breeding back to the original fat tail when the reverse is the case.

The following table, prepared by the commissioners from the Cape Colony, and showing the number of sheep, the weight, and description of the wool produced in the several provinces. will be of interest.

Province.	Number of sheep.	Weight of wool.	Nature of country and climate.	Description and quality of wool.
		Pounds.		
Western	63,897	255,905	Mountainous, with fertile and well-watered valleys suited to viticulture, the leading farming industry; 1,590 square miles.	Seedy, short, and irregular.
Northwestern	981,843	3,816,728	Mountainous, and well watered in the south, arid and uncultivated in the north, but with excellent Karroo pasturage in the eastern portion; 66,040 square miles.	Principa ly mountain wool, which is of bluish color, of long, strong staple. Karroo wool is also grown in parts, and is of yellow color fine texture, but heavy, owing to the nature of the soil.
Southwestern	877,844	2,697,206	Fertile and well watered undulating country, with regular rainfall and temperate climate, affording excellent pasturage in parts; 18,016 square miles.	The principal wool-producing district is Caledon, which produces long combing blue grass veldt of strong staple and good quality, which finds much favor in the American market.
Midland	3,886,480	16,323,870	"Karroo" country; extensive plains intersected with lofty mountain ranges; very fertile, with excellent pasture, but marred by frequent droughts; 63,800 square miles.	The best Karroo wool is grown in this province, varying from very heavy and irregular to long combing, yellow, yolky wools. Through the importation of thoroughbred stock, much improvement is noticeable of late years.
Southeastern	335,048	1,319,344	An arable country with luxuriant grassy slopes, but poor pasturage, known as "sour grass" veldt; temperate climate, with plentiful summer rains; 11,214 square miles.	Grass veldt wools of indifferent quality, but improving during the last few seasons.
Northeastern	2,615,583	11,778,229	Extensive grass veldt plains intersected with lofty mountain ranges; healthy pasturage for sheep; climate dry, with heavy thunder rains in summer; 18,716 square miles.	These provinces produce the grass veldt wool similar to that obtained in some districts of the southwestern province. It differs from the Karroo wool in being more yolky, but not as heavy, and is of a bluish color. The shrinkage is generally from 50 to 60 per cent. These wools are being greatly improved owing to extensive importation of thoroughbred stock.
Eastern	4,636,439	19,561,742	High table-lands comprising the chief pastoral districts of the colony; regular rainfall, and healthy climate; 26,311 square miles.	
Griqualand West	283,577	785,633	High table-land, sandy soil, with little vegetation; climate dry, with extremes of heat and cold; 15,197 square miles.	Grass veldt wool of very superior quality is obtained, but, unfortunately, only in small quantities, which, however, is annually increasing.
Total	13,631,011	56,038,659		

THE ORANGE FREE STATE.

The wools of this little Republic exhibited in Chicago were all of the merino type, and evidently purely bred. Lying at an elevation of 4,000 feet above the level of the sea and in a latitude of the equable climate so favorable to wool-bearing animals, it was to be expected that the product of the flocks would be of very high quality. Unfortunately those in charge of the exhibits were provided with no knowledge of the history of the wools shown, and their intelligent examination by the judges was impossible. So closely adjacent to the

Cape Colony it is natural that the wools should have many of the characteristics of those of that country, and doubtless the stock for the establishment of the original flocks were drawn from that source. On the whole, the fleeces and bales were considered by the judges to be of good quality South African wool, of sound long staple and bright color. They partake of the fineness and softness of the Cape wools, containing comparatively little yolk and grease, and indicate the excellent possibilities of the Republic for fine-wool production.

CANADA.

It was a matter of some surprise to those interested in wool production that the Canadian sheepmen failed to offer representative exhibits of their products. It is true that their highest reputation is for mutton production, and that wool is with them a secondary consideration. Yet the former can not be had without the latter, and surely wools of good quality could be shown. The few samples offered were exhibited by the Northwest Territory, and consisted of one Cotswold and a few pure-bred and crossbred Shropshire fleeces. These do not by any means represent the breeds grown in the Dominion, for the Dorsets, Lincolns, and Southdowns are very popular among the breeders, and are the source of much of the fine mutton exported to the English and United States markets.

THE ARGENTINE REPUBLIC.

It was naturally to be expected that the Republics of South America, in many of which animal production is the leading industry, should be largely represented in the exhibits of wool; and, so far as the Argentine Republic was concerned, there was no cause for disappointment. The commissioners from that country prepared a large and thoroughly representative collection of wool, and displayed the fleeces in a most attractive and instructive manner.

The exhibit contained, besides a large number of fleeces, numbering several hundred, skins with the wool still attached to them, plans of sheep ranches or estancias, photographs of sheep, shelter sheds, runs for disinfectant treatment of the animals, shearing sheds, and ranch scenes generally. And while the information furnished concerning individual fleeces was in some cases limited, the information supplied in the admirable works of Mr. Herbert Gibson, entitled "The History and Present State of the Sheep-Breeding Industry in the Argentine Republic," prepared specially for the occasion, left nothing to be desired. It is so full of facts, not only regarding the industry in the Argentine, but of results of the experience gained in various directions in the production and management of flocks, that it should be anxiously sought after and carefully studied by flock masters in every part of the world. It is to be particularly commended to the sheep

and woolgrowers of this country who at the present time need all the information possible to guide them quickly and surely to the most profitable basis of sheep farming, and particularly to that position in which meat and wool production may be combined without serious detriment to either product, either as to quantity or quality. This seems to have been in a high and satisfactory degree attained in the Argentine, and most intelligently, too, on the estancia with which Mr. Gibson has been so closely identified. It seems both proper and desirable that some abstract, limited though it must of necessity be, should be embodied in this report. In the following pages we shall, therefore, endeavor to present some of the data collected by Mr. Gibson, following pretty closely his text and in many cases his language.

The Argentine Republic, occupying the eastern slope of South America from the River Plate to the south is practically, and so far as the sheep and wool industry is concerned, a broad prairie extending from the sea on the east to the foothills of the Andes and Cordilleras on the west. The land which gradually slopes toward the hills is, therefore, more or less flat or rolling and the elevation above the sea comparatively slight. As we shall see the climate is temperate and particularly well adapted to wool-growing. These facts are best expressed, however, in the following paragraph from the introduction of Mr. Herbert's book. Speaking of the province of Buenos Ayres and the Central Pampa, he says:

> Here is a land covered with nutritious and abundant grasses with no heavy forests to be cleared, no difficulties to contend with. * * * And here also the climate is perfect; the rainfall which varies from 26 to 34 inches is well distributed throughout the year and serves to refresh the grasses and flush the water supplies. The temperature which at its coldest does not descend below 20° F., at its extreme heat in the shade does not exceed 96°. There are neither snow storms nor atmospheric eruptions of any nature sufficient to do damage to the stock or occasion loss. There are no diseases of epidemic character to cause serious mortality, and such diseases as do exist or occasionally visit the country come in such benign form as to be easily dealt with. Neither rabbits nor other destructive animals infest the land. In a word this vast smiling pampa is the home elect of the sheep, and its numerous natural advantages place it far in the van of all sheep-breeding countries.

The history of the sheep and wool industry of the country is most interesting, and Mr. Gibson has apparently collected the data in this particular, as in all others, with the greatest care. From him we learn that the first sheep were brought from beyond the Cordilleras in 1539 by Don Ñufle Chaves, attracting at once the attention of the early settlers of Paraguay. In 1550 Don Juan Nuñez del Prado brought sheep from Peru, and in 1587 Don Juan Torres de Nera y Aragon brought 4,000 Spanish sheep from Peru, distributing them among the provinces of Santa Fe, Buenos Ayres, and Corrientes. These animals were allowed to roam at will and multiply without care

or attention, the energies of the breeders being devoted particularly to the production of cattle and horses. Such a state of things continued till the beginning of the present century. At this time two classes of sheep were found to have developed:

The Pampa sheep descended from the mountain, long-wooled sheep imported by the conquerors from Spain, and the Criollo, or Creole, descended from the Spanish Merino, but so degenerate from interbreeding and other causes as to but little resemble the latter either in wool or type. The Pampa sheep was leggy, with a white face; bare about the neck and belly; sometimes with four and even six horns; hardy and prolific, bearing long, weak wool with no yolk. The Criollo was a smaller animal, many of them black or brown, thinly boned, with shaggy, hairy growth on the neck that had the appearance of a mane; the wool mixed with hair and generally of a slaty or red color.

Merino sheep were imported directly from Spain in 1794, but all trace of these importations seems to have been lost. In 1813 Mr. Henry L. Lindsay imported a flock of Merinos which, after many vicissitudes, ultimately yielded the parent stock for the fine-wool production of the Argentine Republic. The cross between the new, imported Merino and the native Criollo, or Creole, sheep was termed a "Mestizo," and this prevails to-day, being specially applied to the fine-wooled sheep of the Merino type to distinguish it from the long-wool crosses which have since been introduced through the more recent importations of the Lincoln and other long-wooled English breeds.

In 1825 Dr. Bernardino Rivadovia introduced some Southdown sheep, but, on account of the poor yield of wool therefrom, the prevalence of diseases among the flocks and losses caused thereby, the breed was ultimately practically abandoned. Later the long-wooled English breeds were introduced and the popular ones were Lincoln, Leicester, and Romney Marsh.

After a few years' experience most stock owners of experience decided in favor of the Lincolns. They throve well, gave great increase, and their wool sold at a high price in Europe. They made a good cross with the Merino breeds and the cross wools brought exceptionally high figures. For a number of years, however, the Lincolns and other long wools remained unpopular even on those lands where the Merinos manifestly suffered owing to the damp climate and soil. The breeder feared the long, strong wool, accustomed as he was to the golden fleece of his Merino; and the white face and clean legs of the English sheep recalled to his mind the valueless Pampa sheep of his youth, and he dubbed the symmetrical English bleaters with the same name. Not until 1882 did the Lincoln become a generally popular breed, and to-day it disputes the land with the Merino in every corner of the Republic. Thus the Merino breeders saw the whilom despised long-wool produce a better return in every respect, a secure increase, a valuable carcass, and a fleece which topped the market in price. * * * By 1889 Lincoln cross wool became a most important feature in the Argentine wool market and in the present year, 1892, there is no sign of abatement in the furore for long wools.

The greater portion of the sheep stock of the Argentine is of the fine-wooled or Merino sort. The two principal classes which have served as prototypes are the Rambouillet and Negretti, the former being the more popular owing to its superior size. These two great branches of the Merino family have served as standard types up to which

the general breeder aspires to refine his stock. The common fine-wooled flocks all resemble more or less one of these two classes in proportion to the amount of care and outlay which have been expended by their owners to obtain rams of first-class quality. The number of pure Rambouillets and Negrettis is, of course, very limited, and the common flocks are classed as Mestizos, a term specially applied to the sheep which have no other blood in them than the primitive Cridillo improved by crossing with the Merino. The Australian Merino has been introduced upon one or two occasions without obtaining much foothold with the Argentine breeders, who, upon comparing with the Australian animals they saw for sale with their own stock, found the latter better types of their ideal. The Vermont has been introduced from North America and has done well crossed with the Rambouillets.

It is probable that at the present time nearly one-half of the total sheep in the Argentine own to one cross or more with the Lincoln or Leicester breeds, principally. * * * Judging from the continued and still increasing demand for Lincoln sires it may be presaged that in another four or five years the pure Merino or Mestizo stock left in the Argentine will be a small fraction of the whole The years 1888 to 1893 witnessing the conversion of 50,000,000 sheep from one type to another—a conversion probably without parallel in the annals of the sheep-breeding industry.

The most popular of the long wools is the Lincoln. These have been largely imported from England and crossed with the Mestizo sheep, as well as bred pure. The fleece of these first strains is heavy, the wool healthy and fine, being considerably longer in staple than that of the Merino, and still sufficiently soft to suit the manufacturer. The offspring of the long-wooled sire and the Mestizo dam is healthy and vigorous, of a larger build than the Mestizo, and a kindly fattener, more so, indeed, than the later crosses, which approach more the Lincoln in type. As the process of crossing goes on the wool gains in length but loses in fineness. The Lincoln stamps his type upon the stocks very rapidly. Other long wools, such as the Leicester, the Cotswold, and the Romney Marsh, have been introduced without obtaining general favor.

The Romney Marsh, with its healthy frame and soft wool, may possibly become a greater favorite than it is at present when the general breeder has learned to distinguish with greater discrimination than he can at present boast the various classes of English sheep. The Cheviot has also been imported, but in too small quantities to be worthy of notice; nor is it likely that this breed, adapted for a poor cold country, with an inferior fleece of irregular coarse staple and light weight, will find much favor in a land capable of carrying more productive, though more delicate, stock.

There are breeders who hope to preserve the Lincoln-Merino cross as a stamped type by crossing back to the Merino again, when the wool becomes too lengthy and strong. Such an attempt is not likely to be attended with much success, and the breed subjected to this treatment will become prey to all the caprices of atavism. More profitable would be a practice of selection carried out on the same scientific principles that have served to form all the typical breeds of the world, to produce sheep which should, happily, combine a good carcass with a good fleece, holding in view the particular requisitions of the country in which it is to live.

Crosses between the Downs, particularly the Southdowns and Oxfordshire Downs, have been tried without satisfaction. It is said that the wool proved to be of harsh quality and the fleece of light weight. They likewise suffered badly from the diseases incident to the country and climate, and so have been practically abandoned.

Of the several States of the Argentine Republic we have the following information relative to the conditions of sheep breeding and wool

growing. The State of Buenos Ayres is by far the most important as regards the number and distribution of sheep. The author has divided this State into four principal divisions, showing how the sheep are distributed in numbers per square mile:

	Area (square miles).	Number of sheep.	Average number per square mile.
Section I	48,415	48,144,000	995
II	36,840	14,279,000	388
III	18,260	2,417,000	132
IV	6,770	523,000	77
Total	110,285	65,363,000	592

This province carries also 10,422,000 cattle and 2,020,000 horses in addition to about 5,000 square miles under general culture. The author estimates that if we consider "that a cow consumes as much as 5 sheep and a horse as much as 7, then the natural pastures of the province of Buenos Ayres maintain stock at the rate of 186 sheep per 100 acres per annum, * * * the natural pasturage being all the forage consumed."

The average rainfall in this province is 30 inches, the fall being less in the south than in the east and west. The atmosphere is somewhat humid, more especially in the east. Owing to this circumstance and also to the proximity to the meat markets, this is where most of the long wools and their crosses flourish.

In the other provinces the rainfall is reported to be somewhat higher than in Argentina. An average for the localities in Santa Fe is placed at 42.2 inches and that for Entre Rios at 44 inches. In the Pampa, central the soil is light and sandy, the rainfall slight, and the atmosphere a dry one. Merino sheep thrive well here, and the State is undoubtedly best adapted for the fine-wooled breed. The more southern provinces have not yet become important producers of mutton and wool. The distribution of sheep in the entire Republic is shown in the following table:

State or department.	Pastoral area (square miles).	Number of sheep.	Average number per square mile.
Buenos Ayres	110,285	65,363,000	592
Entre Rios	30,000	4,900,000	163
Corrientes	22,000	610,000	28
Santa Fe (south)	23,000	2,400,000	104
Santa Fe (north)	27,000	520,000	19
Cordoba	45,000	1,386,000	31
San Luis	20,000	240,000	12
Santiago del Estero	25,000	780,000	31
Salto	36,000	160,000	5
Pampa, central	65,000	6,000,000	92
Rio Negro	85,000	2,520,000	30
Neuquén	45,000	115,000	3
Chubut	240	17,200	72
Santa Cruz	48,000	26,500	.....
Gallegos	10,350	116,000	11
Total	591,875	85,153,700	142

The exportation of wool from Argentina in 1891 amounted to 310,000,000 pounds, or an average of 4 pounds for each animal, if we accept the enumeration of 78,000,000, and as almost all of the wool is exported this may be accepted as the average net individual yield of the animals. Pure-bred Merinos naturally give larger yields of wool, the weights of fleeces from this breed being about the same as are obtained in other countries. It is stated that well-bred mestizo sheep yield 6½ pounds of crude wool, which shrinks from 60 to 65 per cent in scouring—that is, giving from 35 to 40 per cent of clean wool. The land will support 2½ fine-wooled sheep per acre, but of the long-wooled breeds it will support only two. These latter shear from 5½ to 7 pounds of greasy wool, which is said to lose from 50 to 60 per cent in scouring. Crosses with the Lincoln, which approach closely to the Lincoln type, readily yield from 7½ to 8½ pounds. Such crosses give wool of good marketable quality, and wethers of 1 to 2 years old yield from 55 to 75 pounds of mutton, much sought after by the freezing establishments, and bringing from 3 to 4 cents a pound. On these accounts, and on account of its hardiness and the better quality of the wool produced from it, the Lincoln breed is the favorite for crossing with the Merinos and mestizos. Unquestionably there is much to be learned from Argentina breeders and woolgrowers in the great industry of combined mutton and wool production, and the experience already gained in this far-away southern Republic could find extensive application in many sections of our own country in the advancement of successful management of the flocks for profit.

The descriptions of the estancias of Argentina and their management are full of interest and value. We shall undertake to collate some of the data presented regarding them, the number of sheep in each flock, the yield of the wool, etc.

Los Remedios and Las Acacias: Owned by Messrs. Olivira Brothers. The sheep are Merinos, of French and German origin, the ewes yielding from 10 to 18 pounds of crude wool and the rams from 20 to 28 pounds.

El Carmen: Owned by Dr. Estanislas S. Zeballos. The flocks consist of 1,000 Rambouillet Merinos, 10,000 Lincolns, 1,000 Southdowns, and Oxfordshire Downs. The Rambouillet rams yield 18 to 24 pounds crude wool.

Los Jaqueles: Owned by Mr. Richard Newton. The flocks consist principally of Lincolns and Lincoln crosses.

El Venado: Owned by Felipe Senillosa. This estancia, with an area of 19,760 acres, carries 20,000 sheep, 3,000 cattle, and 300 horses.

The sheep flocks consist principally of Rambouillet Merinos and Lincolns, and the yield from these is stated as follows:

		Lbs.	oz.
34 shearling Rambouillet rams	average per head..	16	3
First stud flocks	do.....	10	12
Second stud flocks	do.....	8	2
General Rambouillet flocks	do.....	5	14
Lincoln:			
First stud flocks	do.....	7	8
Second stud flocks	do.....	7	5
Third stud flocks	do.....	6	10
General Lincoln cross flocks	do.....	5	5

San Felipe: Owned by Don Pastor Senillosa. The area of the estancia is 42,640 acres and it carries 50,000 sheep, 9,250 cattle, and 1,400 horses. The flocks of sheep consist of Rambouillet Merinos, yielding for rams 15 to 26 pounds, and for ewes 8 to 13½ pounds. The yield for the general flocks is 6.29 pounds.

Negrete: Owned by Mr. David A. Shenman. It has an area of 27,300 acres and carries 35,000 sheep, 7,500 cattle, and 1,800 horses and mares. The sheep are made up of the following flocks: One Negretti stud flock, 1 Rambouillet stud flock, 3,500 pure-bred Rambouillet sheep, 30,000 Leicester, 500 Lincoln, 1 Leicester and Rambouillet cross flock. The average yield of crude wool in these flocks is as follows: Negretti stud ewes, 10.48 pounds; Rambouillet stud ewes, 8.70 pounds; Rambouillet general flocks 6.94 pounds; No. 1 Leicester ewes, 7.81 pounds; Leicester general flocks, 6.29 pounds; No. 1 Lincoln ewes, 10.24 pounds; first-class Leicester and Rambouillet, 5.64 pounds; general return from 35,000 head, 6.42 pounds.

Espartillar: Owned by Mr. John Fair. Area, 40,000 acres, carrying 54,000 sheep, 8,000 cattle, 1,900 horses, or the equivalent of 2.50 sheep per acre. The flocks consist of Lincolns and Rambouillet Merinos. The average of crude wool from 21,000 Rambouillet Merinos is 5.42 pounds and that from 33,000 Lincolns 7.77 pounds. The general average for all flocks is 7.01 pounds, and this is said to be the heaviest yield obtained in the Argentine Republic.

Dos Hermanos: Messrs. Santamarina, owners. These gentlemen are owners of 300,000 sheep distributed over several ranches. The area of this ranch is 22,724 acres, supporting 45,000 sheep, 5,000 cattle, and 500 horses, or the equivalent of 3.24 sheep per acre. The flocks consist of 30,000 Rambouillets, 15,000 Lincoln crosses, and the average yield from all is 4.84 pounds of greasy wool.

La Isabel: Owned by Dr. Celedonio Pereda. It covers 15,067 acres and supports 20,000 sheep, 3,400 cattle, and 750 horses, all equivalent to 2.80 sheep per acre. The average yield from the Lincoln stud is 9.33 pounds; from 13,000 Lincolns, 5.64 pounds, and from 7,000 Rambouillets, 5.21 pounds. The general average yield for all flocks is 5.40 pounds.

Manantiales: Also belonging to Dr. Celedonio Pereda. The area of this ranch is 10,600 acres, supporting 10,600 sheep, 4,200 cattle, and 800 horses, equivalent to 2.62 sheep per acre. The yield of crude wool from the Lincoln stud is 9.11 pounds; from 6,000 Lincolns, 5.21 pounds, and from 4,600 Rambouillets, 4.30 pounds.

Frece de Abril: A third ranch, belonging to Dr. Celedonio Pereda, having an area of 40,014 acres and supporting 5,000 sheep, 10,500 cattle, 1,600 horses, equivalent to 1.71 sheep per acre. The yield from the Lincoln stud is 8.05 pounds, while from the general flock Lincolns it is 5.97 pounds.

Nueva Castilla and San Baldomero: These estates, likewise the property of Dr. Pereda, are located near the town of Trenque Lauqueen, in the extreme western portion of the province of Buenos Ayres. Though it has the generous area of 98,800 acres, it is not largely devoted to sheep raising. On one-half the estate Dr. Pereda herds 10,000 sheep, 4,400 cattle, and 1,200 horses. The remainder of the ranch, let to colonists, carries 30,000 sheep. The Rambouillet stud gave an average yield of 8.41 pounds of wool per head, while the average for the entire 40,000 sheep on the estate in 1891 was 4.67 pounds. It is interesting to note that the average yield from 75,000 sheep on the four estates of Dr. Pereda amounts to 4.97 pounds.

Las Barrancas, owned by Mr. Patrick Ried, covers an area of 11,676 acres and supports 19,500 sheep, 2,500 cattle, and 200 horses. This would be equivalent to 2.86 sheep per acre. The flocks consist principally of Lincoln sheep, but there are also some fine-wooled sheep of Rambouillet descent. The latter yield per head from 5½ to 13, scouring to 40 to 42 per cent of clean wool. The Lincoln fleeces weigh from 5½ to 18 pounds, and scouring to 48 to 55 per cent of clean wool.

The Curamalan estate is owned by a stock company. Its area exceeds 700,000 acres, and at present it carries about 300,000 head of sheep, 50,000 head of cattle, and 18,000 head of horses and mares. There are three colonies upon the estate, each with its center of population, and comprising in all a cultivated area of 160,000 acres. These colonies are worked by Russian, Italian, and French emigrants, and are already turning out immense quantities of grain.

The flocks consist of 125 pure Lincoln ewes and hoggets, 63 pure Lincoln rams; 1,995 crossbred Lincoln rams, 300 crossbred Lincoln ram lambs, 254,611 general sheep. The average individual yield of washed wool from 254,100 sheep is 6.03 pounds.

Los Ingleses: The history of the estancia is probably fairly representative of the sheep and wool industry in the Argentine Republic. It is located in the department of Ajo, province of Buenos Ayres, in the vicinity of Cape San Antonio, and is the property of the famous Gibson family. At the present time it is under the management of Mr. Ernest Gibson and Mr. Herbert Gibson, the author of the work

from which the above data have been collated. Originally the area of the estate was 26,356 acres, but this has been increased by various acquisitions to about 65,000 acres. The climate of the section is mild, the maximum temperature during the year never exceeding 90° F. in the shade, and the minimum never falling below 28° F. The atmosphere is moist and heavy dews very prevalent. The rainfall amounts to 32.54 inches annually and is equally distributed throughout the year. The pasturage is therefore abundant and of the best quality. At the present time, land suitable for stock in the estancia amounts to about 36,000 acres. This area carries 75,000 sheep, 15,000 cattle, 8,400 horses, or the equivalent of 2.75 sheep per acre. The flocks are now all of them of the Lincoln type, and for three years, 1890 to 1892, inclusive, the average yield of wool from them was 6.28 pounds per head. For the ten years, 1883 to 1892, inclusive, the yield was 6.66 pounds per head.

From 1868 to the present the flocks have passed through different types of breeding, and after years of breeding the proprietors have finally adopted the Lincoln as the most favorable and most profitable type for all purposes, and the forty-six flocks now held are of this kind. The Romney Marsh was at one time the favorite breed, but this breed was finally abandoned for the Lincoln.

Most of the estancias here mentioned were represented by the product of their flocks in the exhibits in Chicago, and the study of the data here presented in connection with the results of the examinations made by the judges must be a source of profit to those specially interested in the production of either, or both, mutton and wool.

URUGUAY.

The conditions affecting sheep breeding and woolgrowing in Uruguay are in many and, indeed, in most respects similar to those which control in Argentina. The social conditions, the topography, climate, soil, and pasturage are all much the same, and the tendencies in the development of the flocks exhibit naturally like similarities. It is to be regretted that the commission in charge of the exhibits of wool from that country were provided with so limited information concerning the industry and its development. What was available is embodied in the following memorandum from the Hon. Prudencio de Murguiondo, president of the commission:

Without any statistical or historical data at my command that would assist me in giving a description of the wool-producing sheep in the Oriental Republic of Uruguay, with the needs required for so important a matter, I have availed myself of the casual presence of Mr. Romula Chopitea, who is visiting the Chicago Exposition, is conversant with the matter, and has supplied some reliable information regarding this industry in Uruguay.

The report furnished by Messrs. Carlus Maria de Pèna and Honore Rouxtau in 1851 may be said to mark the time when the general demand arose for the improve-

ment of this stock in the Republic of Uruguay. It was checked by the civil and foreign wars at short intervals, causing the fields to be deserted and the farmers to be terrified by the onslaughts of the warring factions, which threatened the partial or entire destruction of their flocks and the progress begun in the interbreeding of their sheep.

Since 1873, however, these interruptions have been less frequent, and the improvement—crossing of breeds—made great headway, and has continued ever since. There is nothing that better proves the exactness of the changing point of this development and improvement of this industry, beginning in 1851, than to see the statistics of the following year, which show the existence of 796,000 sheep in the country, where before the great war, referred to by Dr. Pena, its rich fields were covered with three classes of domestic animals—cattle, horses, and sheep, the two former predominant. A greater part of these fields remained deserted during the war.

The army and guerrillas supported themselves on these animals. The degeneration of the flocks must be attributed not alone to the lack of care and attention of our farmers before that period, but also to the complete desertion and the consequent wild life and intermingling of the different breeds. The general type of these animals when the farmers commenced to domesticate them again was a slender, lean body, thick, coarse wool, without elasticity, though long; fore legs and belly bare. These sheep are called Creoles, while the name "Mixed blood" is given to those preserving some resemblance to the Dorset Horned breed.

Commencing from this time an economical struggle is conspicuous of improvement and importation into the country of several European breeds of sheep which the great landowners believed to be best adapted to their various farms. Doubtless from that date there can be observed a great awakening of the country's energy from the terrors of the dark days of war. The finest specimens of the beautiful German 'Negrete" breed and the finest French Rambouillet breed were introduced into Uruguay, and these continue to be imported on a much larger scale than ever before. These were crossed with the mixed blood, interchanging them in some cases. For several years some raisers have given this matter great attention and have crossed the offspring of the former breeds with large English flesh females, and so far this crossing has given good results, both as regards the fineness of the wool and also the meat, which is bought eagerly by the butchers for food purposes.

The breeds most preferred for crossing are the Lincoln and the Romney Marsh, their choice depending largely upon the conditions of the fields or the taste of the raiser. The Romney Marsh is better adapted for fields with short grasses.

The Uruguay exhibit in the agricultural building at the World's Columbian Exposition shows clearly the progress made in wool products since 1851, and the fleeces have not been prepared for the purposes of exhibition especially. The samples show wool fleeces taken from bales that were about to be exported and in market, and were not selected by the farmers themselves for exhibition.

The number of sheep in Uruguay in 1852 was 796,289; in 1860, 1,939,929; in 1886, 17,245,977, and at this writing about 23,000,000. These figures give solely the number on which the Government has received taxes, and therefore to be considered authentic.

Exportation of wool.

Year.	Quantity.	Value.
	Kilos.	
1889	45,433,529	$9,149,932
1890	21,939,517	7,865,811
1891	25,910,039	8,206,692

I regret that I have not the data of the product and export for the year 1892, but know that it is very much larger than that of the preceding two years.

This memorandum of Mr. de Murguiondo confirms the statement that the conditions of the sheep and wool industry in Uruguay are in every respect similar to those prevailing in Argentina. The flocks are descended principally from the Criollos, or Creoles, and Mestizos, common to the South American Republics, improved by admixture of blood from the English long-wooled breeds and the French and German improved Merinos. As in Argentina, the Lincoln blood has had the preference in building up the flocks, and the Lincoln type therefore predominates. The Merino type is, however, plentiful, and the exhibits in Chicago from Uruguay contained some excellent examples of very high-bred Merino wool. The collection shown indicates that the Republic can furnish material for almost every class of woolen manufacture.

MEXICO.

The exhibits from Mexico in the class of wools were very meager and not of high quality. What was shown was not accompanied by information of a satisfactory character showing the pedigree of the animals producing the wool. Much of the product was from native stock, some of it, however, showing improvement by admixture with Merino blood. The State of Puebla sent some wool of the latter kind, some of it white, some brown and black. The results of our examinations will show fairly well the standard of quality of the staple exhibited and will illustrate the possibilities of the improvement of the sheep-breeding industry in our neighboring Republic.

GUATEMALA.

The character of the wool from Guatemala is naturally similar to that from Mexico. The flocks in that country, such as are to be found, are either pure native breeds or these crossed in a limited way with the Merino blood. The wool is generally short, of dingy color, and from animals apparently badly cared for. That from the native sheep is made up of two classes of fiber, like that of most of the native sheep of all countries, the longer fiber almost hairy in its nature, coarse, rather harsh, fairly lustrous, sometimes elastic and strong, and in other cases brittle and weak; and the shorter fiber of undergrowth, taking the place of fur in other animals and similar in many respects to the wool of the coarse Merino or the finer Down wools. Indeed, the wools of these native sheep of southern North America, and of the mountainous sections of South America are much similar to those of the Fat Tail native breeds of Turkey, Asia Minor, and the East. These breeds of Mexico and Guatemala crossed with the Merino quickly yield progeny giving wool of the highest quality as regards fineness, softness, elasticity, and strength. The equable climate of the elevated table-lands of Mexico and Central America should be the home of enormous flocks of fine wool-bearing animals.

RUSSIA.

One of the most interesting exhibits of animal fibers shown in the exhibition, both to the merchant and the breeder, was that offered by Russia, combining as it did the products of nearly every variety of wool, fur, and hair bearing animals. In previous expositions this country has made splendid exhibits from her justly celebrated flocks of pure-bred Merino sheep, and samples from these flocks were not wanting in this Exposition, though they were not shown in the same profusion as in the earlier expositions in this and other countries. The exhibits in this class were far more diversified, and while good samples of Infantado merino fleeces were shown, visitors had opportunities also to examine the wools of the native breeds of sheep, so curious and interesting in the form and outline of the animals and in the character of the staple. For the sheep breeders and wool growers of the United States it is unfortunate that some literature on the subject of these breeds was not offered, and that the magnificent work of six large quarto volumes, descriptive of the flocks and their management in the different provinces of the Empire, exhibited by the commissioners from Russia, could not be rendered into English for their edification and instruction. It is to be hoped that some good authority on sheep breeding will take up this subject and place the facts concerning these animals properly before the American public.

Of the merino wools little need be said. They are all of the Infantado strain, descended directly from the early importations from Spain. In character these fleeces are more nearly similar to those of France and the United States. They are very dense and heavily charged with yolk and grease common to the fleeces of the colder latitudes. The staple is generally short, scarcely exceeding 2 inches in length in crimp.

The wools from the native sheep are nearly all coarse and consist of the two classes of staple common to sheep which have not been highly improved by selection and special care—the longer hairy portion and the undergrowth of wool. These wools frequently have exceptional strength and elasticity, indicating high value, not only for manufacturing purposes, but the possibility of development from these breeds by crossing with the Merino of flocks capable of producing finer wools of the highest quality for all uses. Among these breeds are the Karakielskaia, the Tshushka, the Tschunduk, and the Tushinskaia. Such crosses do not seem as yet to have been undertaken by the Russian breeders, at least no wools from such crosses were shown, so far as the fine-wooled breeds are concerned. One sample of wool from a lamb of Tushinskaia, crossed with Oxford Down, was shown, which was remarkably fine and strong.

A most interesting sample was one of wool or hair from a cross between a Merino sheep and an Angora goat. Such a cross seems

most remarkable, and is certainly something entirely new in the sheep-breeding industry. The wool seems to partake of the characteristics of both classes of animals represented. It is about 4 inches long, is very fine and strong, has good luster, and if its production can be repeated and increased it must become greatly sought after by manufacturers of certain lines of goods.

Camel's hair was shown in every condition of the crude product and from every part of the animal. Of this staple the most valuable portion is the undergrowth of fur, which rivals in fineness and strength the best merino wool, while for softness and silky luster it can not be surpassed. The colors of the samples shown vary from light gray to dark brown and from the finest fur to the coarsest hair.

To those who incline to the finest fabrics nothing could be more interesting and fascinating than the fur of the brown goat, the utilization of which constitutes such an important industry in the district about Orenburg, furnishing employment for the peasant women during the long winter months when other employment is impossible. These goats are grown in large numbers in this and adjoining districts. Their fleeces are not shorn as in the case of other wool or fur bearing animals, but when the goats are ready to shed their coats the fur is plucked by hand by the women. It is then packed in small bales and sent to the markets, the principal one being that of Orenburg. Grown in the surrounding districts, it is brought to Orenburg by caravan, and here is distributed to the peasant women, who work it up into various kinds of fabrics, for it seems to find the widest uses.

As found in the markets it consists of a mixture of coarse hair and fine fur. Comparatively little of it finds its way to the factories to be worked up by machinery; but, as before stated, it is almost exclusively combed, spun, and woven by the women of the district named.

In the combing process a bunch of the crude material is taken in one hand while a straight needle, similar to a knitting needle, held in the other hand is combed through it. By this means the shorter fine fibers of fur are drawn out, leaving behind the larger and very coarse fibers of hair. The operation is several times repeated, until the fur is finally obtained entirely free from hairs. It is then ready for spinning. Sometimes the crude material is combed by being drawn over a hatchel similar to that formerly used in this country for flax. The fine fiber is held back and preserved and the coarse hairs rejected.

The fiber thus prepared for spinning is placed in bunches upon a peculiar form of distaff, consisting of a narrow board fastened vertically to the end of a bench, upon which the operator may sit. At the top of this board is fastened a coarse wooden comb with its teeth pointing upward. The fibers are then brought into contact with a pointed and rounded stick serving for a spindle, and this latter is then made to spin with one hand while the fiber is drawn down to it with the other.

The yarn as it is spun is wound upon the spindle until sufficient is produced, when it is wound off and made into skeins. Both in the practice of combing and in spinning the peasant women are very expert. They are able to produce yarns of the most uniform quality from the finest to the coarsest, and from the finest yarns, both by knitting and weaving, to produce weblike fabrics of utmost delicacy and beauty of design.

The most beautiful fabrics made by these women are the Orenburg shawls, specimens of which were exhibited in the Women's Building among the products illustrative of the cottage industries of Russia. These shawls are so fine that as many as 1,500 stitches are frequently carried upon a single needle. The persistency as well as the skill of these peasant women who knit the shawls is shown by the fact that a year will often be consumed in making them. Those exhibited in Chicago were 7 feet square (covering 49 square feet), weighed only 8 ounces each and could readily be drawn through an ordinary finger ring. The designs from these shawls are conveyed from generation to generation by inheritance, and when finally others are wanting the women are said to copy the fantastic designs of the frost flowers upon their windows in winter. By this means they are often able to secure most unique effects.

The fur is likewise used for making coarser fabrics, such as heavier shawls and dress goods, particularly attractive because of their softness and silky luster. The staple is never washed until after it is made into fabrics, and even then it is frequently left unwashed. This is particularly true of it when it is made into the heavy homespuns which are used for dresses for the ladies or suits for the men. One of the favorite uses of these goods by the men is in making hunting suits. The residue of animal grease left upon the fiber makes the fabrics practically waterproof, while its strength and resistance to wear makes it almost indestructible. This fur has found its way to the markets of this country and it must prove invaluable in the manufacture of fine yarns. It was shown in the splendid exhibit of Carl Grübnau, of Philadelphia, under the name of noils from Russia. The skin of this goat is also tanned with the fur remaining and the hairs removed, making most attractive fur skins for clothing purposes.

We are indebted to Count Rostofzov, of the Russian commission, for the following very interesting statement concerning the condition of sheep breeding in his country.

SHEEP BREEDING IN THE NORTHERN GOVERNMENT OF RUSSIA, INCLUDING THE UPPER VOLGA REGION AND THE LITTLE KNOWN BLACK EARTH REGION.

In the northern regions of Russia sheep breeding is developed to a certain extent in the following governments belonging to the upper Volga region: Yaroslav, Kostroma, Tver, southern districts of the government of Vologda, and northern districts of the government of Vladimir. These districts are interesting chiefly because they constitute that part of the country where the Romanoff breed of sheep is raised. The

center of breeding of this sheep is the town of Romanov; the farther from this center the less important is the breed of sheep. The other governments of northern Russia are St. Petersburd Novogorod, Pskov, Olonets, and Archangel. In these governments the industry is of scarcely any importance, and sheep are here raised by peasants exclusively for domestic purposes.

Local varieties of sheep, their character and distribution.

In the whole north of Russia but one type of sheep predominates. It is characterized by a short tail, not over 2 inches long and covered with coarse hair. They are for that reason called "short-tail" sheep (*Brachyura*). These sheep constitute a very large group and can be divided into two classes according, chiefly, to their geographical distribution. The sheep of the first class are found in the north of Europe and Asia. They were described by Pallas under the name of the northern short tail sheep (*Ovis brachyura borealis*). The other class found on the Baltic and German seacoast were called by Nathusius the "short-tail" sheep of the plains.

The northern short-tail or Finnish sheep, besides being characterized by its short tail, has the following external and physiological characters: Its height is slight, about 1 archin; its body is covered with long hair, generally gray, which is produced by a mixture of black and white wool; the white fibers grow longer than the black, in consequence of which the sheep change color, and after shearing they are nearly black; then, as the hairs grow longer, they become lighter and sometimes become altogether white. Very often they have a stripe of darker color growing along the middle of the back.

The rams have nearly black withers (one seldom sees perfectly black sheep), the head and legs are destitute of hair and are of a black color, the muzzle is straight, and the horns spiral. In the ewe thè horn is straight and just a little bit curved at the extremity. This likewise sometimes happens with the rams. They are very prolific and the lambs immediately after birth are covered with black glittering down. (The skins of these lambs, taken at from two to six weeks from birth, are cured for furs and furnish the fur known in this country as "Persian lamb" and Astrakhan.) This breed is also found in the governments of Yaroslav, Tver, Vologda, Kostroma, in the southern part of the government of Novgorod, and in the northern part of the government of Vladimir.

Blasius declared that this sheep is not confined to these parts but is also found in northern Asia. The northern boundary of the distribution of this breed in European Russia goes farther north than 59°; the southern boundary extends along the right shore of the Volga, through the northern part of the governments of Nijnii Novgorod and Vladimir, the southern part of Tver, the eastern part of Novogoda, the southern part of Olonets, and then enters Finland.

Within the confines of the distribution of this breed in the northern part of Russia, and in all of southern Russia with very few exceptions, the so-called Russian sheep is raised. This variety of sheep is small, with a thin, rather long tail. The rams have generally long horns, twisted in the shape of a corkscrew. The fleece of wool does not cover the entire animal, and the following parts are covered with a short and coarse hair—the head, beginning with the eyes to the lower jaw, the legs, and the knee.

The staple is 3 inches long and under favorable conditions this becomes of better quality and is not easily compressed. The color is chiefly white, although black and gray sheep are occasionally found; the average weight of the adult sheep is about 70 pounds. Sheep of other breeds are only occasionally met with in this region.

The Merino and Romanov sheep are sometimes found in several parts of the governments of Caloga and Smolensk. According to its geographical distribution this variety of sheep belongs to one of the most ancient. It was probably brought over

to Europe by the Finns from the high plateaus of central Asia, where to this day are to be found sheep greatly resembling it. The severe climate of the countries inhabited by this short-tail sheep has given it a downy fleece. The type has undergone changes under various conditions; in some cases the fleece has become softer and more downy, and in others coarser and shorter.

Professor Tchernopiatov distinguished, besides the Romanov variety of Kostroma, the Voldi, the Moshna, and the Zubstov sheep. The Kostroma sheep is heavily built, but has a gray light fleece, a poor skin (unsuited to the manufacture of leather) and while it is unaffected by extreme heat it does not easily succumb to disease. The Voldi is not noted for its wool, but it makes good mutton and is easily fattened. The Moshna resemble the Voldi sheep, but are generally white. The last-named sheep was a fine animal, but it is nearly extinct.

Externally it is difficult to distinguish the Romanov from the Voloda sheep; for instance, only an expert could tell the Romanov sheep from the higher quality of its wool. The best description of this breed was given by the sheep breeder Gavrilov, twenty-five years ago. The sheep are of medium height; the full-grown animal is about 25½ vershoks long and 16 vershoks in height. The head of the young ram and of the adult ram and ewe, beginning with the middle of the forehead, has a curved profile as far as the muzzle, and this constitutes a very good character of this type of animal. The eyes are full of expression and have a meek glance; the sheep are very tame; the ears pointed and of medium size; the horns of the ram are very like those of the merino; in the ewe they are straight with a crook at the end, but there are animals, both ewe and ram, which are totally destitute of horns. In temper these last named are quieter and better than the others. The wool of the Romanov sheep is of light gray color with light, grayish-brown down which consists of thin fibers 2 vershoks in length. These fibers are straight on all the animal except the neck, where they are curled. The lower parts of the legs and the head of the animal are covered with a different kind of wool, which is black; the fleece reminds one of that of the merino in consisting in waves, as it were, and being oily to the touch; these waves consist of very thin fibers, straight or curved, which constitute the down (or wool) proper; the latter, that is, the down, shows that the Romanov type has either acquired or inherited noble blood. The black sheep are found in small numbers and they are generally kept with the white and gray ones. The gray sheep gives a more valuable skin, but the wool of the black sheep is preferred by manufacturers of Russian boots. (The boots are made of felt.) The quality of the gray sheepskin differs with the time of year, the age of the animal, the order of the sheep, and the coarseness of the wool. This difference is caused by the growth of the coarse black hairs which are called the "pesiga." In the old animals the pesiga grows longer than the white, soft wool, and for this reason the sheepskin has a dark color and does not curl after it is manufactured. The sheepskin is better in summer than in winter or spring. These are all the points of value to be offered with regard to the Romanov breed of sheep, which is really only a variety of the short-tail sheep.

Origin of the Romanov sheep.

The celebrated breeder Gavrilov, who described the Romanov sheep, says they came from crossing the common Russian sheep with the Silesian rams which were brought from Germany in small numbers in the reign of Peter I. Although it can not be proved, some circumstances favor the suggestion. The following characters are similar to those of the Silesian sheep: The softness of the fleece and curliness of the wave, peculiar chiefly to the first class of sheep of this variety; the gray color of the wool was formed from the mixture of the white Silesian sheep with the local black ones. The author of this book thinks that the Silesian animals had nothing to do with the origin of this variety.

Even in the time of Peter the Great sheep of a valuable kind were grown in the government of Yaraslov. Mr. Sokolov thinks that the Romanov sheep appeared in the second half of the eighteenth century and was the product of crossing the Dutch ram with the local sheep. There are many reasons to suppose, though, that the Dutch sheep were introduced in the southern governments of Russia, so that it seems more likely that they had nothing to do with the origin of the Romanov sheep. There is another suggestion of Mr. Sokolov on the origin of the Romanov sheep, that it descended from Kirgiz sheep, but this is not proved. The high value of the Romanov sheep as compared with the other kinds of short-tail sheep is to be referred to the following conditions: The high quality of the soil; better management of the sheep and artificial selection. All these conditions have concurred to produce the breed of sheep known as Romanov.

In this connection the following extract from the consular report (41, May, 1884) of United States Consul Van Riper will be of interest:

The well-known Russian carper wool is a product of the southeastern governments and not to be found equal in length and strength in any other part of the world. The most valuable are the "Savolga"—fleeces, of 4 to 6 inches in length, and as the climate is a very trying one in these provinces the wool becomes soft and downy. The next best quality are the Donskoi fleeces, to be found in the steppes on both sides of the river Don. The production of the Savolga fleeces has diminished considerably during the last decade, as the original breeders of this kind of sheep, the Khirgese, are becoming poorer from year to year. The pastures of these nomads extend as far as the Volga, and the rich flat country bordering the river had placed them in the position for keeping large herds of steppe sheep. Gradually the pastures of the Khirgese were cultivated by the Government, who took possession of them, and they were therefore driven back to the uncultivated steppes, where, in consequence of the bad climate and scarcity of food, their live stock diminished considerably. Peasants settled on the land formerly used for pastures, and began to breed the steppe sheep. These peasants and those of the Don districts are the only ones who breed this kind of sheep, which do not require shelter or much care. Wealthier peasants occupy their time with breeding the merino sheep, which pays them better.

Consul George Scott writes the State Department, May 28, 1885:

There are several denominations of wool, namely, Cherromari, coarse, long wool; Belovadsk, coarse and very long wool; Don wool of the Cossack territory, short or second clip; line, short wool of the Caucasus, soft texture staple; Manitch or Don wool from the villages along the river Manitch, of good length, although clipped in the autumn, and brook washed wool, autumn shorn, also in the grease. All of the above are sold or shipped under the denomination of Donskoi wool. * * *

Russian washed wools are also brought to the ports for sale under the denomination Donskoi. These wools are, the greatest portion, in foot bales, and some in press bales, washed in the interior at Barssiliptz on the river Coper, at Saritsine on the Volga, in the Caucasus, near Stasoropol, and in villages on the river Manitch, also near Cherson. In 1884 something over 5,000 bales were sold to exporters and rebaled.

Merino fine wools grown on the line of the Caucasus, near and along the river Kuban, and in the district of the Don Cossack territory, form a great portion of the commerce in Rostow on the Don. There are many large sheep farms kept by settlers from the Tauride, who took their sheep there during the Crimean war. The high prices paid during some years have enticed many peasants and small farmers to rear this class of sheep, finding it more advantageous than rearing common sheep. * * * A large portion (of the wool) is exported in the grease to France, England, Belgium,

and Prussia. The remainder is sent to the interior towns to be scoured for the Moscow market and manufactories. The weight of fleece of merino wool, is from ewes 6 to 7 pounds, from rams 8 to 9 pounds Russian, but all depends upon the winter, the pastures, the locality, and the spring weather.

It will be observed that the names attached to the samples we were able to secure from the Russian exhibitors are not to be found in the above descriptions, if we except the Donskoi and the Romanov breeds. We can only conclude that the names we have are local and are applied to varieties of these principal breeds grown in the different sections.

SPAIN.

It was to be hoped that in view of the close relations of the Spanish Government and people with the Exposition, and the traditions upon which it was based, that that one of the Spanish products with which our breeders are so closely identified and in which they are so deeply interested, the merino wool, the fleeces from the great Escurial studs and the Transhumante flocks, would be offered in abundance, and be accompanied with such information as would make important additions to our store of knowledge concerning the ancestry of the fine-wooled breeds of this country, which, by careful selection and management, have been brought to such a high state of perfection. The disappointment caused by the very limited exhibits in this class was, therefore, most natural, and the nine fleeces shown attracted almost no attention and were unworthy to represent so important a source of wealth to all the nations into which this Spanish breed has been introduced.

Standing forth among the European countries in the importance of the wool clip, and producing, in 1880, 66,138,000 pounds of wool, it was natural to expect that a substantial exhibit would be made. The official catalogue of the Spanish section describes five separate contributions, but as a fact only two contributions were shown—those of Ortega Saenz Diente, of Cuenca, and of Charques de Perales, of Madrid. The exhibit of the latter, the more important, consisting of seven fleeces of white merino wool, was the most important. It is the product of a Transhumante flock, which is pastured in Villanueva de la Serena (province of Badajos) and in winter in the mountains of Leon. On this account these fleeces are of peculiar interest. When it is considered that these two localities are more than 200 miles apart in a direct line, or as is sometimes said, "as the crow flies," and that much of the intervening country is rugged and uneven, the severe character of this semiannual transfer will be appreciated. Yet this is a most extensive practice in the management of the flocks in Spain, and much of the wool from that country is produced under such conditions.

The fleeces of this exhibit were all light, though weighed in the natural greasy condition, the weights varying from 4 pounds 7 ounces to 8 pounds 7 ounces, while the length of the staple in crimp was 3 inches and under, thus placing it strictly in the class of clothing wool.

The contribution of Señor Saenz Diente consisted of two fleeces, one of black and the other of white merino wool from his flock pastured in the Sierra de Cuenca. The annual production of the flock is stated to be 80 metric quintals, but the number of sheep producing it is not given, and the average is, therefore, not available.

All the fleeces shown were clean and in excellent condition, and indicate careful treatment of the flocks.

TURKEY.

The exhibits of animal fibers from the Ottoman Empire, consisting of wool from the fat-tailed sheep and the hair and fur of goats, though not extensive, were full of interest, and illustrate most plainly the intense conservatism which prevails throughout that ancient domain. In the kind of animals grown and in the management of the flocks no progress seems to have been made in the methods and practices since the country was subject to the influences of the early Hebrew commonwealth. The flocks are still cared for by the shepherds, who lead the flocks from place to place as the judgment of the flock master or the conditions of pasturage, water supply, or the climate dictate. The main principle controlling such movements seems, however, to be the avoidance of the extreme heat and drought of summer and consequent short pasturage by moving to the mountains, and of the inclemencies of the higher altitudes in winter by moving to the valleys in winter.

The exhibits offered were collected from and represent the provinces of Asiatic Turkey, or the peninsula of Asia Minor lying between the Mediterranean and the Black Sea. The product of European Turkey seems to have been entirely neglected by the Commission, possibly because on the other side of the Dardanelles and Bosphorus pastoral pursuits do not have the same prominence, or the flocks are maintained more for the production of meat and milk than of wool.

Almost the sole breed of sheep grown in Asiatic Turkey consists of the celebrated fat-tailed type,* which has become spread over the entire Eastern world, from the Mediterranean and the Red Sea to the Pacific. In Turkey, as elsewhere, they are bred alike for mutton, wool, and the large deposit of fat formed about the tail. These animals, whose pedigree extends to the most remote antiquity, and which are known in their native country as the sheep of Mount Ararat, are kept in flocks of about 200, each under the care of a shepherd. They are said to be excellent travelers, and as they are led from the winter pasturage of the valleys to the summer pasturage of the mountains, they gather food which they readily assimilate; and, in spite of the constant motion in which they are kept, they increase in weight and lay on enormous quantities of fat.

The sheep weigh about 200 pounds alive, and yield when slaughtered

*See Consul Sweeney's report, p. 1575.

carcasses weighing about 150 pounds, the rams weighing generally about 40 pounds more than the ewes. The mutton is considered good, but is prized less than that of the thin-tailed sheep of Roumelia, which furnishes the mutton for the markets of Constantinople. The sheep of these Asiatic provinces are particularly valuable to the natives because of the enormous accretions of fat about the tail, which furnishes almost the only animal fat used in the country. These accretions grow to enormous size, reaching 40 and sometimes 60 pounds in weight, and are said to be frequently so heavy that they are torn away and fall off because of their tenderness and consequent incapacity of the limited connective tissue to support them. For such reason they must be supported, and such relief is furnished by attaching, by suitable harness, a board, one end of which rests upon the ground the other end held up under the tail by the supporting harness provided. Sometimes for greater relief a small two-wheeled cart is provided, which when harnessed to the animal is so held that the tail may rest upon it and it may easily be drawn about as the flocks move from place to place. These deposits of fat are particularly attractive to the dogs and wolves which often attack the flocks. Falling upon the sheep they devour the fat and leave them without other injury.

This fatty tissue in the natural condition is said to contain sometimes as high as 92 per cent of fat, the average yield being about 82 per cent. The fat has about the same consistency as butter, and is used in much the same way.

The bodies of these animals are fairly well covered with fleeces which weigh from 10 to 18 pounds, the faces and legs being bare, or at least covered only with short hair. The wool consists of two kinds of fiber, the longer, which is more hairy in character, coarse and free from crimp, and the shorter or undergrowth of finer wool, having crimp and other characteristics similar to the wool of the Down breeds. In this particular these sheep are very similar to the native breeds of sheep of our own and other countries. The flocks are sheared twice a year, and the spring clip is considered to be the superior. This is used in the manufacture of the finer rugs. The fall clip is short, and is principally used for the coarsest carpets.

The greatest center of sheep and wool growing is the province of Konieh, devoted alike to the breeding of the fat-tailed sheep and Angora goats. Nearly all the provinces of Asiatic Turkey seem, however, to have been represented in the exhibits.

Of the goat hairs exhibited that of Angora or Mohair is by far the most important and interesting. It seems to be grown in all the provinces of the Empire, and samples were exhibited from Angora, Konieh, Sinope, Bordor, Akshekir, Sparta, and the Dardanelles. Samples from Angora were considered by the judges to be "excellent, of good quality, soft and silky." Some of the samples shown were, however,

coarser and harsher to the touch, and were considered to be of inferior pedigree. The fleece is said to weigh about 5 or 6 pounds, and at this weight is of the best quality. Fleeces which are heavier are said to be coarse and less desirable, and to lack the fine luster common to the lighter fleeces. The average weight of fleeces which have been washed upon the animals and pulled will reach 6½ pounds.

The hair is used for manufacture of rugs and for export. It is the only product of the animals that has any value, for the skins can not be tanned because of their tendency to readily tear and split.

In the interest attaching to them and in the value of their products, the Sivas goats are scarcely secondary in importance to the Angora. These animals, which seem to belong specially to the province, are peculiar in that they produce fleeces consisting of the mixture of very coarse hair and an undergrowth of very fine fur. The origin of the type does not seem to be accurately known, but it is believed to be the result of a cross between the fine-haired goats of Russia with the common goat of Turkey. However, they may be an original species, or they may be descended from importations from Russia, for they are similar in many respects as regards the fleece to the goats of the district about Orenburg.

The animals weigh about 60 pounds alive, and yield dressed carcasses weighing about 40 pounds. They yield fleeces weighing from 8 to 9 pounds of the hair and fur mixture already described. The two kinds of fiber are separated by combing, the fur being used for finer fabrics, gloves, stockings, mufflers, etc., and the hair for making grain sacks. The latter is also used for making carpets, rugs, saddlebags, and frequently also for the coats and underclothing of the shepherds.

The most valuable products of these animals are probably their skins, which are shipped mostly to the French market for manufacture into gloves. The skins of kids are worth from 75 cents to $1.50 each in the country of their production.

The goats of Odana produce an exceedingly coarse hair, which would seem to be of little value for textile purposes. The animals yield from 12 to 15 pounds of this product, but it is the least valuable. The flocks are reared principally for the milk of the ewes, each of which is capable of yielding about 2 quarts daily. They are kept in large flocks, frequently to the number of 3,000, and they are always, on account of their hardiness and activity, kept in the mountains where no other animals can graze. When they are grazed near the villages or towns they are driven through the streets and their milk, freshly drawn from them, is delivered to customers after the practice followed in some of the towns of France. The milk is said to be of excellent quality, and it is used in the province for making matzoon, a fermented product similar to that made by the Tartars by the fermentation of mares' milk.

The growing of wool and hair in Asiatic Turkey would seem to be in a fairly prosperous condition. Late statistics published from the statistical bureau of the United States Treasury Department place the production of wool in that country at 17,504,524 pounds, and the same authority shows that the movement of Turkish wools in the United Kingdom of Great Britain increased from 8,689,970 pounds in 1883 to 22,774,764 pounds in 1892.

In addition to the above facts contributed by the commissioners to the Exposition from Turkey the following valuable paper contributed to the Consular Reports of the Department of State by Consul Z. T. Sweeney will be of the highest interest:

SHEEP DISTRICTS.

The whole of Asiatic Turkey may be considered as a woolgrowing country, because every province of Asia Minor produces this article to a great extent. It is interesting to note that the quality produced in every district seems to depend largely on the habits, character, and civilization of the inhabitants of the respective provinces. Thus the greatest exportation of wool in Turkey in Asia, according to the official statistics, is made from Mesopotamia, where the inhabitants are all nomads and have no other occupation than taking care of very numerous flocks of sheep and migrating during the whole year from one region to another, according to the climate and foraging conditions of the country.

Flocks.—Flocks of sheep are not at all as numerous in western and northern Asia Minor as in the valleys of the Euphrates and Tigris. This is, of course, due to the fact that in those parts of Anatolia the inhabitants are much more occupied in cultivating the country than traveling all the year round with their tents and flocks of sheep. A relatively higher degree of civilization and less nomadic life doubtless prevail among the people of Anatolia than those of the desert regions of Mesopotamia.

Wool classification.—Another important point which is generally worth noticing in Asia Minor is that the quality of the wool in each district seems to be influenced by the climatic and topographical conditions of the country. Thus, the wool of the flocks of sheep of the plains of Mesopotamia, and which belong to the Arabs (these people inhabit the whole valley of the southern Tigris, and are divided into achirets, or tribes, to whom belong the flocks of sheep), and which pass the winter outside, owing to the mild climate of the country, is of much finer and cleaner quality than the wool of the flocks to the north, viz, of the province of Koordistan, where the severe winter obliges shepherds to keep their sheep under peculiar roofs, which are called "aghel" in Turkish, and are always inadequate to cover the numerous animals, which very often lie in dirt, and thus the wool is deteriorated to a great extent.

Wool washing.—If we continue our examination by comparing different samples of wool, we find that it is cleaner wherever there are several small rivers which the animals could cross. Wool is free from dust when the flocks live in mountainous regions. There is, for example, a far greater amount of dust in the wools coming from the plains lying east of Konieh or Iconium than in that coming from Angora and the other regions which are mountainous.

Breeds of sheep.—With regard to the different families of sheep in Asia Minor, it must be pointed out that there are actually very few differences among the races of the various districts, and these differences can be divided principally into two distinct classes: First, the flocks of Anatolia—excluding Mesopotamia—belong generally to the family known in Asia Minor as "Caraman." It is indeed difficult to explain why this name has been given to the principal family of sheep in this country.

Perhaps it is because the district of Caramania and the fields of Tchoukourova (low land), which are extending to the south, are the places where a great many shepherds meet, coming with their flocks from all parts of Anatolia every spring in order to shear the wool. Second, the other principal family is that of Mesopotamia, but the sheep belonging to the same differ essentially, according to the different regions, and no general name is given to it. "Karadi" or "Karakash," "Awassi," "Mendelli," "Kerkouk," and "Djaff" are the names given to the different qualities of wool produced in Mesopotamia. The fact is that the flocks of Mesopotamia have been crossed with Persian sheep, of which they maintain the principal element in their blood.

Exports.—It is reported that 35,000 bales are exported yearly from the whole district of Mesopotamia and the greatest proportion of this quantity goes to the United States.

Vilayet of Angora, comprising the districts of Angora, Kerchehir, and Yoozgat.

Sheep and wool.—Comparing the respective figures of the wool clip in the several districts of the vilayet, or province, for the last two years we notice a marked increase in the numbers of the last year. This increase should not be attributed to a gradual increase of the yearly wool production, but to the fact that many flocks perished from cold and severe weather during the winter of 1889, there not being sufficient shelter for them owing to the defective precautionary measures and mortality having increased 20 per cent more than the average.

Breeds.—All the flocks of the Angora vilayet, about 500 in number, belong to the well-known Caraman breed, which in some respects resembles the cross breed.

Exports.—Out of the total production, 1,835,547 okes[a] during 1890 only one-third of the clip of the Kerchehir and Yoozgat have been forwarded to foreign countries, while the remainder, together with the whole production of the district of Cesarea, has been appropriated to local consumption. On the whole the exports from this vilayet are decreasing, local consumption increasing every year, especially for the manufacture of carpets.

Domestic use.—The quantity of the clip retained for local and domestic manufacture is used in making curtains, canvases, carpets, rugs, covers, stockings, bags, and coarse overcoats.

Washing and shearing.—In this vilayet the wool is never washed on the backs of the sheep, but only after being sheared for local use, so that it stands about 50 per cent of the original weight. As regards exportation we must state that washing is practiced comparatively only on a small scale because it does not pay the exporters.

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Clip.—Each male sheep of this vilayet is estimated to give annually 1¾ okes of wool, while the females give only 1¼ okes. It is estimated that both males and females exist in equal numbers in the flocks. About 100,000 sheep are sent from this vilayet to Constantinople, Smyrna, and Brusa for consumption and an equal number are killed for local demand annually.

Shearing.—The male sheep are sheared in the province from the 15th to the 30th of April and the females toward the end of May. During the year 1890 besides the 1,835,547 okes, there were also 100,000 okes of wool sheared from the skins as well as the autumn clip of 350,000 okes.

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[a] 1 oke=2.8 pounds.

Number of sheep and production of wool in Angora in 1889 and 1890:

District.	Number of sheep.		Production of wool.	
	1889.	1890.	1889.	1890.
			Okes.	*Okes.*
Angora	472,742	625,340	709,113	938,010
Kerchehir	185,093	181,781	277,639	277,171
Yoozgat	224,377	273,157	336,565	409,735
Cesarea	132,169	140,421	198,253	210,631
Total	1,014,381	1,223,699	1,521,570	1,835,547

Vilayets of Bassorah, Bagdad, and Mosul, comprising the districts of Bassorah, Amara, Kerbela, Bagdad, Suleymanie, Kerok, and Mosul.

Sheep and wool.—The statistics of the above three vilayets or provinces give a total of 3,600,628 sheep for 1888, and 4,204,851 sheep for 1889, respectively. It must be observed that these figures, although drawn from official reports, can not be relied upon because the official reports are based upon the taxes collected for every head of sheep and, as there are many nomadic tribes which escape paying tax by crossing the frontier into Persia when the collectors of the tax arrive and returning as soon as the officials have left, it is believed that the correct amount for 1889 is 6,000,000 sheep for the three vilayets mentioned. From the afore-mentioned vilayets 34,800 bales of wool were exported in 1888 and 36,800 bales in 1889, the net weight of each bale ranging from 115 to 120 okes.

Breeds.—The principal family of sheep living in the provinces of Bassorah and Bagdad is that of "Chipal." The main feature of this particular breed is that the wool is finer than the other kinds exported from Mesopotamia, the only drawback being the great proportion of color existing in their wool. Only about 20 per cent of the flocks contain white sheep, the remainder being black, gray, fawn and brown. The Chipal breed is very common in these two provinces. Roughly speaking, 80 per cent of the sheep of this region belong to this breed, the remainder to the Karakash breed, the wool of which is used to manufacture carpets, while the Chipal wool, known to the United States as "genuine Bagdad," is used in the manufacture of clothing.

In the province of Mosul the predominant breed of sheep is that of the vilayet of Diabekir, viz, the Arab breed, the wool of which is known in the United States as "Awasi;" the other breed is the Karakash, already mentioned. The Arab or Awasi sheep are met with in the desert of Mesopotamia, while the Karakash sheep generally live near the high, mountainous region of the frontier, because, their wool being much heavier than the Awasi sheep, they can not bear the excessive heat of the desert which they frequent during the winter season.

Variety of wool.—It is interesting to note that the climate influences to a great extent the distribution of different herds of sheep in this region; for instance, the more we get to the south the wool becomes finer and finer, changing from the Karakash to the Awasi, and from this last to the finest of all, the Chipal or Bagdad wool which grows in the warmest districts of Asia Minor. In the same way the nearer we approach to the eastern and mountainous regions the wool grows coarser and coarser, so that the sheep found in the mountainous regions of Persia bear a wool which is heavier than the usual Karakash, and is distinguished from this wool by the name of "Persian Karakash."

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Domestic use.—Some 30 or 40 years ago a very great percentage of the wool production of these districts was appropriated for the manufacture of the stuff which the Arabs use in making their "Jellybas" and "Hyacks" and which is called

"Mechlas." Now the manufacture of these stuffs employs the largest proportion of the wool that remains in the country. Besides the mechlas stuffs, many other woolen articles are manufactured in this province, as in others.

Washing.—In the vilayets of Bagdad and Bassorah the sheep, before being sheared, are washed to a certain extent in the rivers, while in the vilayet of Mosul the wool is only washed after it is sheared, so that it shows about 75 to 80 per cent of the original weight.

Wool classification.—The wool of the vilayet of Mosul is generally of the Karakash breed, while the Bagdad and Bassorah wool is of the Chipal breed. The proportion of these different qualities in the total exports of 36,800 bales for 1889 is as follows:

Chipal breed, 50 per cent, of which 80 per cent was colored and 20 per cent white; Awasi, 30 per cent, of which 80 per cent was white and 20 per cent colored; Karakash, 20 per cent, of which 80 per cent was white and 20 per cent colored.

Number of sheep in each vilayet for 1888 and 1889.

District.	1888.	1889.
Vilayet of Bagdad:		
Bagdad	1,096,033	1,248,141
Hille	221,816	276,233
Kerbela	102,156	104,957
Imperial farms, excluded from official lists	299,951	376,100
Mosque of Kadril, excluded from official lists	29,131	32,000
Total	1,749,087	2,037,431
Vilayet of Bassorah:		
Bassorah	30,131	33,000
Muntefik	500,934	590,000
Amara	213,816	243,000
Imperial farms, excluded from official lists	81,000	90,000
Total	825,881	956,000
Vilayet of Mosul:		
Mosul	462,660	511,200
Kerkook	329,576	401,150
Suleymanie	170,484	179,070
Imperial farms, excluded from official lists	63,000	120,000
Total	1,025,660	1,211,420

Vilayet of Diarbekir, comprising the districts of Diarbekir, Mardin, and Djizire.

Shearing and washing.—The Arab sheep before being sheared are always conducted through rivers, which clean them to a certain extent, and the weight of the wool diminishes 8 to 9 per cent. Karakash wool is never washed when on the back of the sheep, but only after shearing, losing in washing from 25 to 35 per cent. Arab wool is often washed a second time after being sheared.

Domestic use.—About 150,000 okes are used for the same purposes as in the other vilayets.

Mohair goats and sheep.—According to the official reports there were in the vilayet in 1889 1,084,000 sheep, 191,000 mohair goats, and 799,000 black-haired goats. For the year 1890 there were about 1,053,000 sheep, 186,000 mohair goats, and 751,000 black-haired goats. About 2,000,000 black goats and sheep are killed in the vilayet every year and sent away for consumption.

Clip.—The total clip of this vilayet is estimated to be about 1,200,000 okes, composed of three different qualities, viz, 40 per cent is the well-known Karadi, or Karakash, quality (the breed of sheep which produce this particular quality is known in Asia Minor under the name of "Kurdestan" and the wool is called "Kurd" wool); 30 per cent is composed of particularly fine wool, called Arab, or Awasi, wool, the finest production of the province; the remaining 30 per cent is the poorest of the whole production, which comes from all parts of the province.

Breeds.—The Arab sheep are found to the south of Mardin, where they remain winter and summer, while the Karakash sheep emigrate in summer to the higher regions toward the north of Mardin, near Diarbekir, because they can not withstand the excessive heat of the desert, their wool being much heavier than that of the Arab sheep.

To the south of Diarbekir, in the desert region which lies betweed Aleppo and Mosul, there are about 6,000 tents of nomad tribes, which are continually moving about, and whose sheep are not included in any of the official lists. Some of these tribes do not pay any tax at all, and others pay only insignificant sums as compared with the number of sheep they possess, which is estimated at more than 300,000 head, with a wool production of about 350,000 okes. This wool is sold by the tribes as they go on their journies through the different provinces.

Vilayet of Kastamoonie, comprising the districts of Kastamoonie, Kankaree, Boli, and Sinope.

Breeds and wool.—The flocks of sheep in this vilayet also belong to the Caramania breed, there being little difference between the respective clips of the various districts. The wool exported from the district of Kankaree and Boli is the finest of all, being full growth and fine in quality.

Clip.—The total clip may be estimated in round numbers at 600,000 okes for the whole province, of which 100,000 okes only are exported, while the remainder is appropriated for local consumption, for the same purpose as in the province of Angora.

Shearing and washing.—The above exports include 10,000 okes of wool exported on sheep skins, forwarded without being sheared to foreign countries. The wool is exported from this vilayet in its greasy state, and is only washed for local use so as to lose about half the original weight of the sheared wool.

Mohair goats.—There are in this province about 544,840 mohair goats. The following statement shows the number of sheep in each district of Kastamoonie in 1890:

Kastamoonie	169,704
Kankaree	122,406
Boli	149,601
Sinope	65,265
Total	506,976

Vilayet of Konieh, or Iconium, comprising the districts of Konieh, Teké, Hamid (or Sparta), Bordour, and Nigdeh.

NUMBER OF SHEEP AND EXPORTS OF WOOL IN EACH DISTRICT OF THE VILAYET OF KONIEH IN 1890.

Districts.	Exports of wool.	Number of sheep.
	Okes.	
Konieh	318,945	495,800
Teké	150,570	171,800
Hamid (or Sparta)	70,950	98,400
Bordour	66,375	59,000
Nigdeh	178,600	195,000
Total	785,440	1,020,000

Wool.—The total clip in this province is more than 1,500,000 okes, 785,440 okes of which are exported.

Sheep.—Roughly speaking, the sheep are pretty nearly evenly divided, half being males and half females. A male sheep yields yearly about 2 okes of wool, while the females yield not more than 1.5 okes per head. The average yield is about 1.5 okes per sheep per year.

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Wool classification.—There is but little difference of quality between the wool of the vilayet of Konieh and that of Angora. The last name is given in Europe and America to Konieh wool, and in the United States all wool coming from western Asia Minor passes for Angora wool.

Washing and shearing.—No washing is practiced in this province except for local use and on a very small scale for export. There is a custom in this province of shearing the wool a second time, in August, when the sheep, before being sheared, are conducted through small rivers and are washed to a certain extent.

Variety of wool.—The wool coming from the east of Konieh is rather dusty, because the sheep live on the plains which extend over a vast region of the country.

The facts presented in Consul Sweeney's paper will give added interest to the following transcript of the notes made by the judges during their examination of the Turkish exhibits of wool. It must be remembered that according to the statement of the commissioners for Turkey all of the wools were from the fat-tail sheep, and that no other names of breeds were given by them.

24351. A. 22. Province of Bordour; lamb's wool; good carpet filling or blanket wool.

24352. 528. Province of Bordour; wool in the fleece; a soft, desirable wool; 7-inch staple.

24353. Province of Sniope; wool in the fleece.

24354. Province of Bordour; mohair.

24355. 534. Province of Sniope; mohair; 2 samples.

24356. Province of Konieh; mohair; 2 samples.

24357. Province of Sniope; mohair.

24358. Province of Beirut; wool; washed.

24359. A. 34. Province of Broussa; wool; washed; a short, soft filling wool without much character.

24360. A 29. Province of Konieh; wool; unwashed; small staple; too small to report on.

34370. 532. Province of Sniope; wool; black. Fair sample of black wool; 5 inches long.

24371. 35. Province of Sivas; sheep's fleece; good quality; long, sound staple; excellent fleece.

24372. 576. Province of Konieh; sheep's fleece

24373. 561. Province of Konieh; lamb's fleece; 3 samples; fairly long, soft staple; washed carpet.

24374. 560. Province of Konieh; ewes' fleece; two samples; a fine, soft, useful wool, suitable for purposes other than carpets; staple, 6 inches.

564. Province of Konieh; soft carpet wool; somewhat irregular in quality; very cotted; 4½ inches long.

24375. Province of Konieh; rams' fleece; 2 samples; fair character; one quite low in quality.

24376. 562. Province of Konieh; fleece; rather tender; cotted; heavy in condition and very irregular in quality.

24377. Province of Aksher; mohair.

24378. A 43. Province of Smyrna; fleece; soft wool with a good deal of kemp; tender and somewhat cotted.

24389. A 20. Sivas; wool; white, coarse, strong haired, tender bottom; 9 inches long.

24389. A 21. Wool; black.

24390. 616. Province of Sniope; white wool; soft carpet or blanket wool; too cotted to be combed to advantage; 5 inches long.

24392. 563. Province of Konieh; sheep wool; ram, 3 years; rough wool, running down low on skirts and very kempy.

24393. A 30. Province of Kastamoong; wool; a good soft worsted carpet wool, of uniform quality, 7 inches long.

24394. Province of Adana; goat hair.

24395. Province of Dezadj; goat hair.

24399. Province of Aksher; sheep wool.

B 22. Province of Angora; mohair, an excellent sample; good quality; very soft and silky.

B 23. Province of Angora; mohair; coarser than B 22, and inferior in color and staple; apparently not full blooded.

B 24. Province of Angora; mohair; very fine quality; short staple and soft to the touch.

B 25. Province of Angora; mohair; similar to B 22, but very short staple.

The exhibits illustrated the irregularities to be found in the quality of the product from Turkey, and consequent to the management of the flocks and the climate in which they are reared. It is believed that they were fairly representative of the clip of the provinces named.

EXHIBIT OF MR. CARL GRÜBNAU, OF PHILADELPHIA.

It is but fair to say that no part of the exhibits of class 60 was more unique in character or more interesting than this collection, due to the public spirit, intelligence, and enterprise of Mr. Carl Grübnau, of Philadelphia. Bringing before the wool producers and consumers of this country for their inspection and instruction large specimens, not merely hand samples, of the animal fibers produced in nearly every foreign country and devoted to the uses of man, he has done a work of the greatest value, and for which most hearty thanks are due. We can not undertake here to offer a catalogue of these specimens. Such a catalogue will be found in our table of results of the tests of samples of these products. It is sufficient to say that almost no country seems to have been neglected and that every variety of commercial product is represented. It is at least true that Mr. Grübnau has brought together all the products coming to the markets of the United States, and therefore of any value in the eyes of our producers and consumers. The collection will speak for itself, and the results we have to offer will serve to illustrate the wide variations in the animal fibers, not only in different but in the same breeds, and even in the same breeds in the same localities. The figures presented will be worthy of close study, and in a very important measure will serve as a comparative standard of quality of the products from the different sources of supply.

THE UNITED STATES.

It was a matter of common and frequent observation and remark in the World's Fair that the exhibits of wool from the different States of the Union were by no means representative of the industry which manages annually 45,048,017 sheep, worth $891,186,110, and produces each year 348,538,138 pounds of wool. It is true that many of the best breeders of the country sent examples of their work, and that it was possible in what was shown to find wools as good as any produced in the country, and, indeed, in any part of the world, but the quantity offered was not sufficiently massive to be really impressive and amply illustrative of the progress that has been made here in this great industry. It is true that most of the States which constitute particularly the breeding centers of the country, and from whose stud flocks stock for improving the flocks of the Far West are sent out, furnished fleeces. These were, in some cases, unaccompanied by such information concerning them as was required by the authorities, and so were excluded from competition, and therefore of official examination by the judges. But the large flocks of the great ranches of Texas and the highlands of the Far West were conspicuously absent from the Fair, and the sections which produce the larger portion of the wools sent to market from the United States were not represented at all, or were inadequately represented by a few fleeces of indifferent or inferior quality.

It would be difficult to undertake anything like sectional classification of the wool production of the United States as represented in the exhibits offered with the expectation of showing marked differences in the quality of the product. Thus far the sources of supply for breeding material have been so uniform and the rules and methods of breeding have had so much in common that like results must of necessity be expected in fairly widely separated sections of the country. Thus, from external appearances, it would be practically impossible to detect appreciable differences in the merino wools of different strains produced in Vermont, Michigan, Minnesota, or Missouri, yet, for convenience of description and consultation, and in a measure offering like qualities of fleeces, we may consider together the exhibits of the North and East, including Vermont, New York, Pennsylvania, and West Virginia; those of the eastern portion of the north central section, including Ohio, Indiana, Illinois, and Michigan; those of the western portion of the north central section, including Wisconsin, Minnesota, Iowa, and Missouri; those of the highlands, including South Dakota, Wyoming, Colorado, Utah, and Arizona; and, finally, those of the Southern States, Kentucky and North Carolina being practically the only States of this section represented.

To begin with the States of the North and East, these States—Vermont, New York, Pennsylvania, and West Virginia—have been justly noted for the high grade of the flocks of fine-wooled sheep developed for breeding purposes, and it was entirely natural that the fleeces sent from them should consist largely and even principally of that type of wool. In Vermont the Merinos of distinctly Spanish origin have always been the favorite, and from them many of the strains celebrated under different names throughout the country have had their origin. The same integrity in breeding that has always characterized the flock owners is still maintained and is manifest in the wools they offer for exhibition. A dense fleece of long staple, covering completely a large symmetrical body, with fibers of good though not of maximum fineness and of high strength and elasticity, is the end aimed at and is the result generally secured. It was satisfactory to find among the fleeces exhibited those from the veteran breeder Albert Chapman, whose untimely death leaves a serious void in the circle of fine-wool breeders, and whose stud flock has had such an important influence upon the fine wools of the country. The fleeces constituting the collection from Vermont are from animals of medium or light weight, but producing heavy, dense fleeces. The weights of animals we find to range from 82 to 132 pounds, and the weights of the fleeces from 12 to 27 pounds. Such relations must preserve the reputation of the Vermont flocks.

Of the other Northeastern States Pennsylvania and West Virginia are, at least so far as the exhibits of wool indicated, devoted to the Merino breed. The sheep breeders of these two States, their aims, and their interests are so closely interdependent that their exhibits may properly be considered together. It is greatly to be regretted, however, that these breeders should have been so lax in the preparation and presentation of their exhibits that they should not have had them in place for exhibition until so late in the progress of the Exposition that they could not be properly examined by the judges, and that the information furnished with the fleeces should have been so scanty as to make examination and report unsatisfactory and almost impossible. That the wool exhibited was of high quality need scarcely be stated. Both States furnished fleeces of the highest order and in numbers sufficiently large to be representative of the fine-wooled breeds, and some of the best stud flocks were represented, too. From such data as were furnished it appears that the tendency of the breeders in Pennsylvania is to the production of larger animals with proportionally lighter fleeces. Thus the weights of the animals range from 85 pounds to 165 pounds, and the weights of the fleeces from about 8 pounds to 16 pounds.

Of the fleeces from West Virginia we secured only a few samples

from the more than 50 fleeces exhibited, and of the latter we have no information whatever concerning the weights of the animals and but little about their fleeces. The fleeces of Saxony Merinos, the production of which is confined almost entirely to West Virginia, are naturally very light, but their fineness leaves nothing to be desired. It is believed, and without doubt justly, that as fine wools as can be found anywhere in the world are produced from these sheep. Neither of these States offered specimen fleeces from the stud flocks of long or middle wools which are particularly to be found in such perfection in the eastern portions of Pennsylvania. These flocks are bred, however, so almost exclusively with a view to mutton production that it is scarcely surprising that they should have been ignored on this occasion.

The exhibits from New York State were prepared with the highest care and intelligence. It is believed that all the pure breeds of sheep found in the State were represented in the Exposition. The number of fleeces, though not large, included at least 4 from each breed. This latter is true of the coarse wools, 2 rams' fleeces and 2 ewes' fleeces being offered in each case. Naturally here also the Merino fleeces predominate, and among them we find excellent illustration of the possibilities of the production of long, fine wool upon large, strong bodies. Thus we find here animals yielding fleeces weighing from 7 pounds to 27 pounds, of quality as regards length, fineness, evenness, softness, and strength leaving nothing to be desired. Among the the fleeces we find some from the flocks of Mr. W. G. Markham, of Avon, N. Y., the progeny of whose flocks are to be found in almost every part of the world. The efforts of Mr. Markham and other breeders to produce animals capable of producing good yields of fine, strong wool upon large carcasses, and so making posisible combined production of mutton and wool, bids fair to be realized, and the Rambouillet sheep, weighing 300 pounds and giving 15 pounds of fine wool, belonging to his flocks are convincing examples of this fact.

Of the coarse wools represented little need be said. The records of our examinations will show them to be reasonably fine for their respective classes, and both strong and elastic. It is interesting to note that the collection contained examples of the Chevoit and the Dorset Horn fleeces from breeds thus far but little known in our country and of probable value and usefulness for some sections of our country. It is true that both these breeds have been received with scant favor in those countries other than that to which they are native, but in this country the interests are so varied and the conditions so different that places will doubtless be found where they will serve a good purpose, either for propagation of the breed itself for meat production, or for transmission of the blood to other and less hardy breeds for the production of the more vigorous and precocious crosses.

It is possible that Ohio, which is classed with the Central Northern States, should be classed with the Eastern States also. The interests of the breeders of this State have been so closely allied with those of Pennsylvania and West Virginia, and the families of Merinos in all three so closely related, that in any extended consideration of the Merino races in this country it is almost impracticable to consider them separately. Nevertheless, in many respects in the sheep-breeding and wool growing interests Ohio stands alone and independent. Her reputation for the production of fine wool is undisputed, and the expectation that the commission from that State would offer a large and varied collection was fully realized. Ohio furnished the largest exhibit of fleeces offered from the United States. Not only was the collection a large one, but it was handsomely exhibited and contained an extended variety of wools. It is by no means surprising that the Merino fleeces should predominate, for the State is so greatly devoted to the production of fine wools. So, in addition to the Merino wools, we find also those of the Cotswold and Leicester, Shropshire Down, and Oxford Down.

In this collection all the strains of the Merino blood seem to be represented, and here, as in the exhibits from other States, we find fleeces of from 15 to 25 pounds weight from animals weighing from 100 to 175 pounds. Such live weights illustrate the tendencies and aims of the American breeders to produce large, hardy, well-covered frames rather than to produce exceedingly fine wool; to secure animals which may serve to infuse their qualities of good frame and vigor and large wool production into flocks in which small frames and light fleeces predominate, or may serve for crossing with the coarse-wool breeds for production of animals giving simultaneously good yield of mutton and wool.

The collection further illustrates the progress being made by the breeders of the State in the effort to produce new and better strains of Merino blood. Thus we find frequent crossing of the large frame and long staple of the Delaine type with the small frame and short, exceedingly fine staple of the Saxon or Silesian type descended from the early and celebrated importations of Welles and Dickinson. Such a cross producing live weight of 115 pounds with a fleece of nearly 10 pounds is a good result, and experiments of this kind, combining the principles of crossing with judicious selection, carried on with the skill and intelligence common to the American breeder, can not fail to bring about a substantial elevation of the standard of our flocks.

In strong contrast with the wools of Ohio, consisting principally of the fine wools, are those of the immediately adjoining State of Indiana. In a collection of about 50 fleeces scarcely half a dozen were of the merino type. If we may judge from these exhibits, the sheep breeders

of Indiana are devoting their energies more especially to the production of mutton than of fine wool. The Cotswold and the Down breeds seem to be the favorites, and in addition to the few merino fleeces already mentioned the collection was made up of fleeces of Cotswold, Southdown, Oxford Down, and Shropshire Down. The records which accompany these are full of interest and well worth careful study. Cotswolds are represented in rams weighing from 175 to 300 pounds, having fleeces of 13 pounds. Ewes of the same breed weighing 130 to 180 pounds gave fleeces of 8 to 10 pounds. Southdowns weighing from 100 to 160 pounds gave fleeces of 3 to 12 pounds of wool, which, it must be confessed, was not of exceedingly high quality. Oxford Downs and Shropshire Downs show the best record among the Downs, both for live weight and weight of fleece, the former weighing up to 200 pounds and the latter to 185, with fleeces of from 4 to 14 pounds of wool of medium quality.

The sheep breeders and woolgrowers of Illinois failed to offer to the judges for their inspection a collection of fleeces in any degree adequate to represent the extensive flocks of the State. The latest statistics show that the animals in these flocks number ——, and yet the records of the judges cover only 7 fleeces from two exhibitors. One fleece seems to have been the only representative of the fine-wool flocks, and the splendid studs of long-wooled sheep, so widely known throughout the country for excellent stock, were represented by only one exhibitor.

Similar apathy concerning the Exposition seems to have prevailed among the woolgrowers of Michigan, though to not the same degree. The few fleeces offered to the committee of judges for their inspection were of excellent quality, and, it is believed, fairly representative of the product of the State. The exhibit consisted principally of merino and Shropshire Down fleeces, the latter coming from animals yielding 12 to 15 pounds of good wool, while the merino fleeces contained from 12 to 36 pounds of wool of good length, fineness, and strength.

The collection of fleeces from Iowa was likewise limited as to number, but it was probably representative. It consisted of about equal numbers of fleeces of fine and coarse wools. Among the latter the indications to be derived from the exhibits show that the Downs are preferred by the breeders, Shropshire, Hampshire, and Southdowns and Dorset Horn being represented. The Shropshire and Southdowns weighing from 80 to 148 pounds gave fleeces weighing from 7 to 15 pounds of fairly good wool. A Dorset Horn ram 3 years old gave 8 pounds 9 ounces of wool of good quality, and seems to justify the favor this breed seems to be receiving in different parts of the United States.

The Merino wool from Iowa, like that from Michigan, is mostly of the Delaine type, from animals of medium weight and giving fairly good fleeces as regards both weight and quality.

In the exhibits of wool in the Exposition, therefore, the States of Michigan, Illinois, and Iowa were about on the same plane and were very inadequately represented. The same may also be said of Minnesota, whose breeders have heretofore furnished such excellent material for exhibition and who are constantly sending good wools to the market. It is, therefore, remarkable that our collection of samples and the fleeces examined and reported upon by the judges of awards should consist entirely of Shropshire Down wool. Even if we take into account the serious decline in the number of sheep in the country during the past few years it can scarcely be possible that the Merino and grade flocks have entirely disappeared.

From Missouri a very excellent collection of wools, principally Merino of the Delaine type was exhibited. Grown upon animals whose live weights are reported to be from 110 to 200 pounds, it is not surprising that the fleece weights should range from 12 to over 36 pounds. But little information was furnished with the fleeces concerning the history of the animals which produced them, but it would seem that if they were bred to the capacity to lay on fat like the Down breeds the matter of combined wool and mutton production would be solved. Among the coarse wools the Shropshire and Southdowns seem to be preferred, and if the other coarse-wool breeds are grown in Missouri these collections do not show it. In this case the Downs seem to have smaller live weights than the Merinos, which is interesting, at least, if not surprising.

For much, if not most, of the fine wools of the home market we depend upon the States lying west of the Mississippi and more lately admitted to the Union. Situated as they are at the higher elevations, having a climate more or less well suited to grazing, and areas available for the development of large flocks, the production of wool in many of these new States has far surpassed that of any of the older States. Yet the woolgrowers have manifested the same sort of apathy with regard to the Exposition shown by their Eastern colleagues. South Dakota, Montana, and Utah furnished samples of the product, the only collection of importance being that from South Dakota. This collection offered a great deal of interest for the woolgrowers on account of the different kinds of wool it contained and the facts furnished with the fleeces. Many of them, indeed most of them, were cross-bred wools, but they were all of known origin and served well to illustrate the progress taking place in systematic crossing. The tendency seems to be to give prominence to the Down types in these crosses, and in this the Shropshire Down seems here, as else-

where in the country, to have the preference. At the same time representative fleeces of other crosses were shown, and we find specimens from the first, second, and third crosses of the Merino with the Shropshire Down, Southdown, Cotswold, and Lincoln offering opportunities for study and comparisons by those interested in the general improvement of the flocks for general use not frequently found. So also the collection contained specimen fleeces from crosses of the coarse-wool breeds; the Downs and long wools, and both these with the native sheep. Altogether it must be admitted that this was one of the most interesting and instructive exhibits in this department of the Exposition. Much pleasure and profit must be found in the careful study of the results of the detailed examination of these wools presented in tables further on. Wyoming, Montana, and Utah furnished a number of fleeces consisting mostly of grade Merino wools of really excellent quality as regards fineness and strength. From Wyoming we had the ordinary grade Merino wool in fleeces weighing from 9 to nearly 25 pounds. From Montana the fleeces were somewhat lighter but of much the same quality. Those weighing from 8 pounds to nearly 22 pounds were shown, produced upon animals weighing from 100 to 135 pounds. The wool is of the Delaine type, generally ranging above 2.5 inches in length in crimp.

Utah furnished practically nothing to illustrate the extension of wool production within her borders. The few fleeces of Merino wool shown were of good quality and weight, and are a mild indication of what might have been possible in the matter of an exhibit.

Wools from the Pacific coast were confined to a few fleeces and small samples from Oregon, concerning which almost no information could be obtained. With the favorable climatic conditions which prevail in the great States of Oregon and Washington, the wool production should be large and of high quality. The latter is indicated in the few samples from Oregon.

The so-called Southern States were almost without represention in the wool cases. Save a few fleeces from Kentucky and North Carolina, and one from Virginia, that section failed to furnish anything to the collection. The great State of Texas, with her enormous flocks and large product, failed to appear. Kentucky was naturally represented in the Down wools, and this is true of North Carolina. In both these States the Southdown seems to be favored as of old, though the Oxford Down is also to be found. The fleeces from the two States are from both these breeds. In Kentucky, animals weighing from 150 to 200 pounds yielded from 5 to 8 pounds of wool of not very uniform quality, and yet in many cases of good strength. Of the fleeces from North Carolina we have no information beyond what was brought out in our examinations, as will be seen farther on.

As we have already stated, it is to be regretted that the exhibits from the United States were so meager, and that they were in many cases so badly prepared for exhibition. Our exhibitors have yet, in our opinion, much to learn from their foreign competitors, yet what was offered has contained a great deal of valuable material for the examination we have prosecuted, and careful study of the results thereof will be found of value for future work.

Details of history and average results

DOMESTIC.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARIZONA.						*Pounds.*	*Lbs. oz.*	*Inches.*
Navajo Indians		1a	Navajo black wool.					4
Do		1a	....do					
Do		2	Navajo white wool.					2.50
Apache County		1b	Shropshire Merino.	Wether.	3 yrs	107	10 1	1.30
Do		2a	Grade Merino.	....do	2 yrs	111	4 12	1
Do		2a	....do	....do	2 yrs	111	4 12	
Do		3	....do	Ewe	2 yrs	97	4 1	1
Do		4	Shropshire Merino.	....do	1 yr.	113	5 2	1.75
Do		5	....do	Ram	1 yr.	137	8 15	3.50
COLORADO.								
W. Lamont	26806	1	Native	Wether.	1 yr.		7 8	4
Do	26807	2	Shropshire	Ewe	1 yr.		9 10	3
Do	26807	1a	....do	....do	1 yr.		9 10	8
Agricultural College	26808	3	....do	....do	1 yr.		11 0	4
Do	26809	4	....do	....do	2 yrs		12 11	9
Do	26810	5	....do	....do	1 yr.		13 4	5
Do	26811	6	Merino	....do	2 yrs		19 14	
Do	26812	7	Shropshire range.	Wether.	1 yr.		11 8	1 50
Do		7	....do	....do	1 yr.			
Do	26813	8	Merino	Ewe	1 yr.		16 11	2.50
Do	26814	9	Shropshire range.	Wether.	1 yr.		10 7	4
Do	26815	10	....do	....do	1 yr.		7 12	3.25
ILLINOIS.								
Wm. A. Young	5704		Shropshire Merino.	Ewe	4 yrs	102	2 7	3.34
Do	5705		Cotswold	....do	4 yrs	98	3 0	2.43
Do	5706		....do			120	14 7	8.74
Do	5709		Oxfordshire Merino.	Ewe	4 yrs	100	3 9	2.05
Do	5708		Oxfordshire Cotswold Merino.	....do	4 yrs	96	4 6	2.91
E. Peck & Son	5707		Pure Merino	....do	3 yrs	94	16 9	2
INDIANA.								
Peter Shock		0	Shropshire	Ram	2 yrs		6 8	2
Campbell		0	Grade Merino.	Ewe	2 yrs		5 4	
Eli Helser, Warsaw	5511	1	Shropshire	....do	1 yr.	135	10 14	5
Do	5512	2	....do	....do	2 yrs	165	11 15	5.14
B. McLean		3	....do	....do	2 yrs		4 11	2.75
Robt. H. Mitchell, Princeton.	5495	5	....do	....do	2 yrs	180	8 12	3.50
Ryse & McLean, Shelbyville.	5507	7	Oxfordshire Down.	Ram	1 yr.	130	7 15	
Do		8	....do	....do	2 yrs	200	11 11	5.25
Sid Conger, Flatrock		9	....do	Ewe	2 yrs	200	9 4	6
Ryse & McLean, Shelbyville.	5510	10	....do	....do	2 yrs	180	10 0	5.75
Do	5506	11	Cotswold	Ram	2 yrs	300	12 0	9.42
Do	5509	12	Oxfordshire Down.	Ewe	1 yr.	130	6 2	8.63
Do	5508	13	Cotswold	....do	2 yrs	180	7 11	4.50
S. B. Morrison, Shelbyville.	5505	14	....do	....do	1 yr.	150	10 2	8.75
Do	5502	15	....do	Ram	2 yrs	160	11 3	5.25
Do	5501	16	Oxfordshire Down.	Ewe	2 yrs	190	9 8	5
Do	5498	17	Cotswold	....do	1 yr.	130	7 12	9
C. Huston	5499	18	Southdown	....do	1 yr.	110	5 0	5
Do	5520	19	....do	....do	14 mos.	123	7 0	4.71

of tests of individual samples of wools.

DOMESTIC.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R.$	$E = \frac{R}{P}$	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Fraction of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
2.5695	1.012	$\frac{1}{25}$	6.041	93.226	7.966	39.83	14.64	16,569	41,600	Fine.
.....	.....	.....	26.783	413.3244	8.682	43.41	64.90	73,461	169,226	Coarse.
2.2515	.886	$\frac{1}{1128}$	.....	.....	.....	.....	.....	.....	.....	
1.994	.785	$\frac{1}{1273}$	4.833	74.58454	5.558	27.79	19.448	22,062	79,208	
1.857	.731	$\frac{1}{1367}$	9.150	151.20599	7.324	36.62	28.88	32,685	89,259	Fine.
5.0245	1.978	$\frac{1}{505}$	34.683	535.2800	7.532	37.66	21.98	24,878	66,060	Coarse.
2.395	.943	$\frac{1}{1060}$	6.375	98.38122	4.632	23.16	17.78	20,125	86,900	
2.357	.928	$\frac{1}{1078}$	.....	.....	.....	.....	.....	.....	.....	Too fine to mention.
1.849	.728	$\frac{1}{1373}$	5.183	79.98585	4.232	21.16	24.256	27,453	129,840	
2.5695	1.012	$\frac{1}{25}$	15.233	236.0807	8.774	43.87	36.91	41,782	95,241	
2.116	.833	$\frac{1}{1200}$	6.516	100.55718	6.416	32.08	23.284	26,353	82,149	
3.938	1.554	$\frac{1}{64}$	26.67	411.580	6.432	32.16	27.516	31,143	96,840	
3.711	1.461	$\frac{1}{68}$	24.858	383.6172	7.550	37.75	28.878	32,684	86,580	
3.490	1.374	$\frac{1}{72}$	12.975	201.2326	6.940	34.70	19.4577	22,020	63,460	
3.274	1.288	$\frac{1}{78}$	18.975	293.8287	8.390	41.95	28.31	32,049	76,399	
2.4185	.952	$\frac{1}{1050}$	11.166	172.3174	7.104	35.52	26.267	29,730	83,068	
3.361	1.323	$\frac{1}{75}$	22.300	344.1414	8.824	44.12	31.585	35,747	81,023	Unwashed.
3.1145	1.226	$\frac{1}{81}$	20.36	312.2	7.364	36.82	33.598	38,021	103,200	Washed.
2.266	.892	$\frac{1}{1120}$	6.866	106.05	5.266	26.33	21.394	24,215	91,966	
2.291	.902	$\frac{1}{1108}$	10.916	169.459	8.124	40.62	33.24	37,628	92,637	
2.893	1.139	$\frac{1}{877}$	10.991	170.716	5.750	28.75	21.01	23,984	82,728	
2.482	.977	$\frac{1}{1023}$	11.041	170.3884	6.308	31.54	28.67	32,457	109,714	
3.257	1.282	$\frac{1}{78}$	22.50	347.22	4.774	23.87	21.412	38,409	160,910	
3.315	1.305	$\frac{1}{76}$	28.116	433.8858	8.716	43.58	40.935	46,330	106,315	
2.611	1.028	$\frac{1}{972}$	10.691	165.087	5.916	29.58	25.081	28,391	95,992	
2.438	.962	$\frac{1}{1041}$	14.683	242.0253	7.268	36.34	39.516	44,725	120,260	
2.558	1.007	$\frac{1}{993}$	7.891	121.87667	5.200	26	19.295	21,838	66,700	
3.4085	1.342	$\frac{1}{74}$	10.608	162.163	5.408	27.04	14.60	16,522	61,125	
1.9915	.784	$\frac{1}{1275}$	5.925	92.436	5.532	27.66	28.914	27,067	97,856	
4.148	1.633	$\frac{1}{61}$	12.125	187.117	6.474	32.37	11.27	12,750	39,405	
3.711	1.460	$\frac{1}{68}$	15.55	239.972	3.800	19	18.108	20,447	107,610	
3.2795	1.291	$\frac{1}{77}$	10.958	170.107	6.016	30.08	16.29	18,445	61,312	
3.419	1.346	$\frac{1}{742}$	47.83	737.63	8.316	41.58	65.467	74,096	178,200	
3.9625	1.560	$\frac{1}{630}$	16.66	159.431	5.800	29	16.98	19,218	66,275	
4.3915	1.729	$\frac{1}{57}$	22.341	344.774	9 140	45.70	18.53	20,982	45,915	
4.087	1.609	$\frac{1}{62}$	17.683	272 890	8.516	42.58	16 93	19,160	45,015	
3.444	1.356	$\frac{1}{737}$	21.995	340.5345	13.432	67.16	29.67	33,580	66,496	
3.258	1.2826	$\frac{1}{78}$	14.20	219.12	81.74	40.87	21.404	24,226	59,261	
3.452	1.359	$\frac{1}{736}$	16.84	248.76	3.890	19.45	22.611	25,591	131,560	
3.963	1.560	$\frac{1}{630}$	20.116	310.437	9.074	45.37	20.48	23,180	51,105	
5.169	2.035	$\frac{1}{491}$	21.508	331.918	8.392	41.96	12.87	14,570	34,720	
2.8665	1.285	$\frac{1}{78}$	19.333	308.353	7.940	39.70	37.64	42,607	107,320	
3.505	1.380	$\frac{1}{724}$	23.26	358.95	7.866	39.33	30.293	34,286	87,984	
3.800	1.496	$\frac{1}{68}$	17.316	167.2264	9.274	46.37	19.178	21,703	46,804	
3.325	1.309	$\frac{1}{76}$	12.250	189.0462	7.750	38.75	17.72	20,065	51,780	
3.526	1.388	$\frac{1}{720}$	14.758	232.0993	8.390	41.95	18.981	21,484	51,204	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
INDIANA—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
O. E. Replogle		20	Shropshire	Ewe	2 yrs			
Do	5515a	20	do	do	2 yrs	180	14 15	4
Do	5515	21	Southdown	Ram	2 yrs	150	6 0	5.25
Do	5515b	21	Shropshire	Ewe	1½ yrs	165		2.25
Wm. Whipple	5516	22	Southdown	do	11 mos.	97½	3 13	2.57
Do	5516	23	do	do	1 yr.	110	6 5	4.37
Do		25	do	do	14 mos.	130	5 5	3.25
Bell Carpenter, Shelbyville.	5490	26	Grade Merino.	Ram	14 mos.	150	3 12	2.50
C. Collwell, Wabash	5517	27	Shropshire	Ewe	1 yr.	148	12 0	4
Do	5517	28	Grade Merino.	Ram	1 yr.	145	11 6	4
Do	5517	28	do	do	1 yr.			
Brolbins Bently		29	Shropshire	Ewe	3 yrs.	185	11 6	5.25
Toby Williams		30	do	do	1 yr.	135	11 0	5.25
W. M. Coleman, Winteroud.	5528	31	Cotswold	Ram	1 yr.	175	13 0	9.50
C. Huston	5500	32	Southdown	Ewe	1 yr.	100	12 0	3.50
No name		33	do	Ram	2 yrs.	160	8 6	5.50
C. Huston	5521	34	do	do	3 yrs.	140	7 12	4.50
W. M. Coleman		35	Cotswold	Ewe	1 yr.		8 14	6.50
A. W. Dolph, Teegarden	5523	36	Shropshire	do	1 yr.		9 9	4.50
Do	5524	37	do	do	2 yrs.		8 3	6.36
W. M. Coleman, Winterwood.	5526	38	Cotswold	do	2 yrs.		10 2	9.50
Do		39	do	do	1 yr.		8 7	8.50
Do		39	do	do	1 yr.			7
Do	5527	40	Shropshire	do	1 yr.		7 14	5
Peter Shafe	5492	42	do	do	1 yr.		5 12	4.50
Bell Carpenter, Shelbyville.	5518	44	Grade Merino.	do	2 yrs.		5 3	2
C. Huston	5491	45	Southdown	do	1 yr.	100	3 6	3
IOWA.								
B. L. Bates, Nassau	5405	1	National Delaine and Spanish Merino.	Ewe	2 yrs.	70	7 4	3.43
J. J. Edgenton, Nassau	5406	2	National Delaine Merino.	Ram	2 yrs.	112		
Do	5407	3	do	do	1½ yrs.	98	8 7	2.76
Do	5408	4	do	Ewe	2 yrs.	72	12 5	
Do	5409	5	do	Ram	1 yr.	77	11 11	3.34
Do	5410a	6	do	Ewe	2 yrs.	78	11 8	4
Do	5410b	7	do	do	2 yrs.		8 12	4
Do	5411	8	do	Ram	3 yrs.	132	13 5	2.31
N. H. Edgenton, Nassau.	5412a	9	Shropshire	Ewe	1 yr.	90	15 11	3.78
Do	5412b	10	do	do	1 yr.	101		
Do	5412c	11	do	do	1 yr.	82	7 12	3
Do	5412c	11	do	do	1 yr.	82		
J. H. McKibbon, Albion.	5413	12	American Merino.	do	3 yrs.	84½	18 0	2.25
R. J. Blakely, Grinnell	5414	13	do	Ram	1½ yrs.	92½	21 13	2.08
Agricultural College, Ames.	5415	15	Dickinson Delaine.	Ewe	1½ yrs.	83	12 10	2.70
Do	5416	16	Hampshire	do	356 dys.	115	6 12	3.61
Do	5417	17	Shropshire	Ram	2 yrs.	185	10 11	
Do	5418	18	Southdown	Ewe	2 yrs.	97	6 15	
Do	5419	19	do	do	1 yr.	98	8 10	4
Do	5420	20	Dorset	Ram	3 yrs.	220	8 9	4.25
Do	5421a	21	Southdown	Ewe	3½ yrs.	142	8 0	
Do		21	Dickinson Delaine.	do	3 yrs.	100	14 2	2
Do	5421b	22	Southdown	do	3 yrs.	158	8 0	3.50
Do	5421c	23	Hampshire Down.	do	3 yrs.	100	7 13	2
C. L. Gabrilson, New Hampton.	5422	24	Shropshire	Ram	11 mos.	148	11 13	4

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109 \frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
3.840	1.512	1 1/2	16.633	256.686	7.616	38.58	18.044	20,423	52,937	Washed.
2.855	1.234	1 1/4	15.016	233.9543	5.632	28.16	29.475	33,360	118,468	Unwashed.
3.6425	1.434	1 7/16	20.975	469.1123	7.866	39.33	25.294	28,628	72,790	Do.
3.190	1.256	1 1/4	15.16	1233.95	4.140	20.70	23.836	26,916	13,020	Washed.
2.745	1.081	1 1/8	8.063	124.74	5.750	28.25	17.163	19,425	68,764	
3.276	1.290	1 5/16	7.716	218.076	6.458	32.29	11.503	13,019	40,320	
3.558	1.401	1 3/8	13.200	103.706	6.642	33.21	16.303	18,452	57,664	
2.497	.983	1/64	7.450	14.97	5.174	25.87	19.11	21,638	83,640	
1.796	.707	1/64	4.933	76.12777	5.316	26.58	24.469	27,6[illegible]1	104,193	
2.240	.882	1/32	4.650	717.604	6.940	34.70	14.827	16,782	48,364	Unwashed.
2.403	.946	1/64	4.500	69.44557	5.550	27.75	12.468	14,112	50,805	Washed.
3.957	1.558	1 1/2	14.358	221.575	6.658	33.29	14.66	16,591	49,850	
3.439	1.354	1 3/8	14.800	228.497	6.958	34.79	20.02	22,660	65,138	
3.772	1.485	1 1/2	24.816	382.296	8.574	42.87	27.90	31,578	73,660	
3.010	1.185	1 3/16	14.20	219.13	7.332	36.66	25.077	28,252	77,420	
3.1865	1.2546	1 1/4	25.89	399.62	7.828	39.14	40.81	46,188	118,000	
3.043	1.198	1 3/16	15.363	257.0870	6.358	31.79	26.54	30,038	94,490	
4.049	1.594	1 5/8	17.583	271.3467	7.590	37.95	17.15	19,418	51,168	
3.163	1.245	1 1/4	12.941	200.6899	7.590	37.95	20.694	23,422	61,718	
3.727	1.467	1 7/16	14.875	229.556	7.566	37.83	17.13	19,395	51,262	
2.9655	1.1676	1 1/8	24.46	377.45	9.340	46.70	44.516	50,383	107,850	
2.279	.897	1/32	14.425	222.611	6.524	32.62	44.42	50,277	154,480	Unwashed.
2.977	1.172	1 3/16	13.075	201.977	6.2750	31.375	23.604	26,716	85,492	Washed.
2.616	1.030	1 1/16	11.350	175.157	6.758	33.79	26.53	30,035	88,888	
3.792	1.493	1 1/2	15.908	246.497	6.132	30.66	17.692	20,024	65,310	
2.212	.871	1/32	6.025	92.979	7.708	38.54	19.79	22,401	57,858	
2.634	1.037	1 1/4	13.166	203.082	8.074	40.37	30.34	34,348	85,085	
2.002	.788	1/64	4.325	66.7449	6.190	30.95	17.26	19,545	63,137	
2.500	.984	1/64	5.666	87.439	6.066	30.33	14.50	16,410	65,668	
2.106	.829	1/32	5.758	88.84945	8.450	42.25	20.77	23,510	65,650	
1.753	.690	1/64								
2.881	1.134	1 1/8	8.025	123.844	7.124	35.62	15.469	17,508	49,154	
1.626	.640	1/64	3.991	63.690	7.682	38.41	24.783	28,050	73,089	
1.961	.772	1/32	6.975	108.64	7.740	38.70	29.02	32,845	84,483	
2.439	.960	1/64	5.766	88.98292	6.858	34.29	15.50	17,558	51,189	
3.259	1.283	1 1/4	11.35	175.17	8.008	40.04	17.098	19,351	48,331	
2.810	1.106	1 1/8	11.758	181.4534	7.144	35.62	23.82	26,965	75,710	Unwashed.
3.216	1.266	1 1/4	12.541	193.5369	6.732	33.66	19.40	21,956	35,235	Washed.
2.855	1.124	1 1/8	5.425	73.72049	7.174	35.87	10.64	12,055	33,605	
2.332	.918	1/32	6.950	108.24482	6.300	31.50	20.447	23,143	73,470	
2.073	.816	1/64	6.133	94.64659	5.816	29.08	22.834	25,843	88,870	
3.215	1.265	1 1/4	13.033	205.7121	7.974	39.87	20.17	22,834	57,270	
2.830	1.114	1 1/8	13.07	201.39	7.416	37.08	26.11	28,880	77,885	
3.272	1.288	1 5/16	19.475	310.5448	7.950	39.75	25.69	28,415	71,488	
3.523	1.387	1 3/8	19.475	310.5448	7.950	39.75	25.69	28,415	71,488	
3.437	1.353	1 3/8	19.918	318.3814	8.754	43.77	26.353	29,826	68,144	
2.073	.816	1/32	7.258	112.007	7.800	39	27.147	30,585	78,423	
2.353	.926	1/64	11.350	175.1561	6.724	33.62	32.875	37,123	110,420	
2.873	1.131	1 1/8	13.700	211.4231	8.266	41.33	33.534	37,954	91,833	
2.160	.850	1/32	6.825	105.7825	7.310	36.55	23.405	26,490	72,477	
3.127	1.231	1 1/16	16.991	263.2956	7.724	38.62	34.991	39,603	102,540	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
KENTUCKY.								
						Pounds.	*Lbs. oz.*	*Inches.*
Cassius M. Clay, Whitehall.	26787	1	Southdown...	Ram....	2½ yrs...	210	7 6	2.50
F. L. Vermont, Millersburg.	26788	2	.....do.....	Ewe....	4 yrs....	153	7 8	4.63
D. E. Lowell, Rabbit Hash.	26789	3	.....do.....	Ram....	2 yrs....	156	7 9	2.99
Do	26789	3	Oxfordshire Down.	Ewe....	1 yr.....	.....	7 10	3.73
Do	26790	4	Oxfordshire and Southdown.	....do...	14½ mos.	113	7 14	3.28
Do	26791	5	.....do.....	....do...	1½ yrs...	154	11 8	4.38
R M. Fisher, Danville..	26792	6	Southdown...	....do...	5 yrs....	180	7 15	4
Cassius M. Clay, Whitehall.	26783	245	.....do.....	....do...	1½ yrs...	200	5 0	3
Do	26784	264	.....do.....	....do...	2½ yrs...	200	5 14	3.25
Do	26785	266	.....do.....	....do...	1½ yrs...	.....	6 1	.....
Do	26786	267	.....do.....	....do...	2½ yrs...	200	5 6	2
Eugene McGoodwin, Danville.	26796	.....	.....do.....	....do...	1 yr.....	123	7 6	.....
Cassius M. Clay, Whitehall.	26782	255	.....do.....	....do...	2½ yrs...	200	5 10	2.55
MICHIGAN.								
A. A. Wood, Saline.....	26766	1	Spanish Merino.	Ewe....	2 yrs....	.....	16 12	.....
Do	.....	1	.....do.....	....do...	2 yrs....	.....	.....	.....
Do	26767	2	Pure Merino .	....do...	2 yrs....	.....	15 8	2.57
Do	26768	3	Merino.....	....do...	.....	.....	16 2	2.82
Do	26769	4	Pure Merino .	....do...	2 yrs....	.....	19 14	2
Do	26770	5	.....do.....	Ram....	2 yrs....	.....	21 3	2.25
Do	26771	6	Merino.....	Ewe....	5 yrs....	.....	25 0	.....
Do	26772	7	Pure Merino .	...do...	2 yrs....	.....	25 12	1.45
Do	26773	8	.....do.....	....do...	2 yrs....	.....	14 0	.....
Theo. Willows, Saline....	26775	10	Shropshire ...	Ram....	2 yrs....	.....	15 3	4
Do	26776	11	.....do.....	....do...	363 dys .	.....	15 8	3
Do	26777	12	.....do.....	Ewe....	2 yrs....	.....	.....	4.50
Do	.....	12	.....	.....	.....	.....	15 10	.....
Do	26778	13	Shropshire ...	Ewe....	3 yrs....	.....	12 15	3.25
Davis Olney, Ludington .	26779	14	Merino.....	Ram....	6 yrs....	139	36 4	3
H.S.McMaster, Dowagiac	26780	15	National Delaine Merino.	....do...	2 yrs....	.....	12 8	.....
MINNESOTA.								
A. R. Spaulding.....	5743	1	Shropshire Down.	Ewe....	1 yr.....	.....	7 6	5.14
Do	5745	7	.....do.....	....do...	3 yrs....	.....	6 12	3.08
Do	5746	15	.....do.....	....do...	2 yrs....	.....	7 5	4.11
Do	5748	28	.....do.....	....do...	1 yr.....	.....	6 2	3.08
Do	5749	44	.....do.....	....do...	2 yrs....	.....	6 13	.....
Do	5750	50	.....do.....	....do...	2 yrs....	.....	8 2	.....
Do	5751	57	.....do.....	....do...	4 yrs....	.....	7 13	3.08
Do	5752	207	.....do.....	....do...	4 yrs....	.....	4 12	.....
MISSOURI.								
L. E. Shattuck, Stanbury.	5389	1	Merino.....	Ram....	3 yrs....	235	36 12	2.25
Do	5390	2	.....do.....	....do...	2 yrs....	195	40 11	.....
Do	5391	3	.....do.....	....do...	1 yr.....	142	20 2	2.25
Do	5392	4	Spanish Merino.	....do...	3 yrs....	145	12 0	3
Do	5393	5	.....do.....	Ewe....	2 yrs....	155	16 13	2
Do	5394	6	.....do.....	....do...	1 yr.....	123	14 9	2.43
Do	5395	7	Delaine Merino.	Ram....	2 yrs....	180	19 15	3
Do	5396	8	Merino.....	....do...	3 yrs....	200	19 6	2.25
Do	5397	9	.....do.....	....do...	1 yr.....	135	13 1	2.23
Do	5398	10	Delaine Merino.	Ewe....	1 yr.....	110	16 2	3.25
Do	5399	11	.....do.....	....do...	2 yrs....	140	16 1	2
Do	5400	12	.....do.....	....do...	3 yrs....	155	20 2	3

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R.$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
3.358	1.322	1/32	9.683	159.43	4.858	24.29	13.735	15,550	64,020	
2.860	1.126	1/32	10.30	158.95	3.850	19.25	20.147	22,803	118,460	
2.972	1.170	1/32	12.00	185.18	4.474	22.37	21.73	24,600	109,950	
3.015	1.187	1/32	16.37	251.07	5.758	28.79	28.81	32,610	113,250	
3.046	1.199	1/32	10.10	155.88	3.882	19.41	17.417	19,713	103,250	
3.1195	1.228	1/32	20.00	308.64	7.408	37.04	32.79	37,230	100,500	
2.665	1.049	1/32	11.36	175.31	3.608	18.04	25.592	28,965	160,560	
2.7955	1.105	1/32	8.475	130.7891	4.446	22.33	17.35	19,639	87,960	
2.812	1.107	1/32	7.866	121.388	5.966	29.83	15.915	18,010	60,390	
2.515	.990	1/32	10.50	162.03	4.358	21.79	26.56	30,060	137,900	
2.9095	1.145	1/32	11.008	169.879	6.866	34.33	20.79	23,539	68,568	
2.6215	1.032	1/32	10.066	155.33	5.582	27.91	23.43	26,510	95,010	
2.423	.954	1/32	7.966	123.93409	6.190	30.95	21.709	24,571	79,390	Unwashed.
2.011	.7918	1/32	6.041	93.226	5.816	29.08	23.90	27,113	92,968	Washed.
2.088	.822	1/32	5.766	88.98292	5.332	26.66	21.160	23,950	89,835	
1.890	.744	1/32	6.050	93.365	6.542	32.71	27.09	31,385	93,765	Unwashed.
2.510	.988	1/32	8.200	126.545	7.532	37.66	20.826	23,570	62,298	
1.872	.737	1/32	6.483	100.947	5.250	26.25	29.599	33,501	127,620	
1.8415	.725	1/32	4.833	78.16795	5.482	27.41	22.81	25,820	92,060	Washed.
2.281	.898	1/32	6.825	105.325	8.058	40.29	20.988	23,754	59,641	
2.162	.851	1/32	6.125	94.424	9.516	47.58	20.965	23,729	49,873	
3.419	1.346	1/32	21.45	33.102	7.580	37.90	29.359	33,229	87,676	
3.3095	1.303	1/32	20.716	319.696	9.108	45.54	30.26	34,251	75,211	
3.2005	1.260	1/32	13.166	203.1821	5.976	29.88	20.56	23,276	77,898	Unwashed.
2.977	1.172	1/32	14.43	222.68	8.658	43.29	22.54	25,520	58,950	Washed.
3.668	1.444	1/32	21.866	337.4435	7.658	38.29	26.00	29,431	76,867	
2.3315	.918	1/32	13.050	201.392	6.790	33.95	38.41	43,474	128,054	Do.
2.1845	.860	1/32	5.108	80.939	6.416	32.08	28.897	25,895	80,721	
2.906	1.144	1/32	7.658	118.220	4.958	24.79	14.51	16,425	66,242	
3.8785	1.527	1/32	16.583	255.9144	7.150	35.75	17.63	19,965	55,845	
2.695	1.061	1/32	9.708	159.817	6.308	31.54	21.38	24,205	76,743	
3.1525	1.241	1/32	17.975	279.3963	7.800	39.00	28.93	32,753	83,969	
3.678	1.448	1/32	16.375	252.687	7.558	37.79	19.361	21,914	57,987	
3.145	1.238	1/32	10.700	165.12	4.950	24.75	17.307	19,590	79,150	
2.2375	.881	1/32	8.325	128.4723	6.316	31.58	26.64	30,161	95,509	
3.0505	1.201	1/32	12.825	197.9197	6.932	34.66	22.05	24,958	72,009	Do.
2.121	.835	1/32	6.866	105.95	6.966	34.83	24.41	27,638	79,352	
2.218	.873	1/32	7.733	119.338	7.432	37.16	25.15	28,465	76,602	
2.012	.792	1/32	5.716	88.211	6.350	31.75	22.59	25,570	80,535	
2.393	.942	1/32	5.691	87.925	6.732	33.66	15.90	17,992	53,465	
2.210	.870	1/32	6.725	103.781	6.924	34.62	17.495	19,803	59,201	
1.743	.686	1/32	5.533	85.387	6.790	33.95	29.139	32,980	97,145	
2.212	.871	1/32	6.725	103.781	7.416	37.08	21.99	24,889	67,123	
2.253	.887	1/32	5.108	79.828	7.682	38.41	16.10	18,225	47,443	
1.791	.705	1/32	5.956	92.915	7.300	36.50	29.709	33,624	92,122	
2.205	.868	1/32	5.308	81.914	7.466	37.33	17.46	19,770	52,960	
2.149	.846	1/32	6.516	100.557	7.766	38.83	22.57	25,550	65,801	
2.149	.846	1/32	5.600	86.421	5.700	28.50	19.40	21,958	77,048	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
MISSOURI—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
John Kugler, Stanbury	5694	13	Delaine Merino.	Ewe	1 yr.		15 3	2.25
Do	5695	14	Merino	do	2 yrs.		19 1	2.80
Do	5696	15	Delaine Merino.	do	3 yrs.		21 10	2.52
Do	5697	16	Spanish Merino.	Ram	352 dys.		23 9	3
Do	5698	17	do	do	325 dys.		20 5	2.24
Mrs. N. H. Gentry, Sedalia	5691	20	Shropshire	do	2 yrs.	125	5 13	3.25
Do	5692	21	Southdown	do	2 yrs.	120	4 13	2.31
Do	5693	22	Southdown and Merino.	Ewe	2 yrs.	100	6 15	2.37
Henry Gilmere	5699	23	Merino	Ram	2 yrs.	195	8 4	3.58
G. B. Bothwell	5401	24	do	Ewe	2 yrs.	140	16 14	
Do	5402	25	do	Ram	6 yrs.	160	22 10	2.91
Do		26	Southdown	do	2 yrs.	120		
Do		27	Shropshire	do	2 yrs.	125		
MONTANA.								
Frank O'Donnell, Cove Sheep Ranch.	5377	1	Pure Merino	Wether	3 yrs.	85	12 8	3
Wm. H. Clanton, Billings		1a	do	do	4 yrs.		6 9	2.36
Do	5374		do	do	4 yrs.	90	8 2	2.36
Robt. F. Martin, Billings		3	do	Ewe			8 2	3
Do		5	Delaine Merino.	Ram	3 yrs.		21 8	2
Do	5378	6	Oxfordshire	Wether	3 yrs.		14 0	3.25
Do	5380	7	Spanish and Delaine.	Ram	4 yrs.	130	12 2	2.76
Do	5381	8	do	Wether	4 yrs.	135	13 0	3.23
Do	5382	9	Pure Delaine	do	4 yrs.	135	8 4	2.50
Smith Bros., Martinsdale		4	Shropshire grade.	do	2 yrs.	94	8 2	3.50
Thos. McGirl, Billings		6a	Merino	do		110	15 8	2.50
E. M. Zenizon & Bros., Shawmut.	5376	10	do	do	400 dys.	70	8 12	3.23
Thos. McGirl, Billings	5379	11	do	Ewe	4 yrs.	100	13 4	4
S. D. Church, Billings	5375	12	Grade Cotswold.	do	5 yrs.	100	9 6	2.50
A. Laney	5385	13	Pure Merino	do	2 yrs.	100	9 9	3.50
Clark Bros., Chateau	5386	14	do	do	2 yrs.		6 13	2.50
Renn Bros., Terry	5384	15	Merino	Wether	3 yrs.	100	10 4	2.45
A. M. Cress, Miles City	5388	16	Southdown	Ram	2 yrs.	83	4 0	
		17						
NEW YORK.								
J. Horatio Earll, Skaneateles.	4659	1	Pure Merino	Ram	3 yrs.		27 0	
Do	4658	2	do	do	2 yrs.		22 8	2.25
Do	4611	3	American Merino.	Ewe	2 yrs.		15 15	2.50
Do	4612	4	Pure Merino	do	13 mos.		15 1	2
C. O. Partridge, Peoria	4662	5	American Merino.	do	2 yrs.		16 8	2.25
Do	4615	6	Rambouillet	do	2 yrs.		14 12	
Markham & Ray, Hemlock Lake.	4663	7	do	Ram			14 7	2.17
Do	4616	8	Rambouillet	do	1 yr.		6 7	2.25
Do	4664	9	do	Ewe	2 yrs.	115	12 16	2.70
Do	4617	10	Pure Merino	do	1 yr.		14 7	3
David Cossett, Onondaga	4665	11	do	Ram	5 yrs.		23 7	1.75
Do	4657	12	do	do	12½ yrs.		11 1	2.50
Do	4610	13	do	Ewe	5 yrs.		10 15	2
		14	do	do	11½ mos.		11 8	3
B. J. Wylie, Marcellus	4660	15	do	Ram	3 yrs.	125	20 10	2.50
Do	4661	16	do	do	2 yrs.	120	20 8	
Do	4613	17	do	Ewe	2 yrs.		13 12	2.50
Do	4614	18	do	do	10½ yrs.		7 10	2.75
John P. Ray, Hemlock Lake.	4607	19	American Merino.	Ram	2 yrs.		29 6	2.25
T. J. Wyman, Lakeville	4651	20	do	do	3 yrs.		11 8	

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2 S'} =$	$18109\frac{S}{D^2} =$	$E=\frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
1.999	.787	$\frac{1}{32}$	4.858	74.970	6.666	33.33	19.45	22,012	66,051	
1.920	.756	$\frac{1}{33}$	5.108	78.827	4.608	23.04	22.17	25,092	108,900	
2.040	.803	$\frac{1}{31}$	5.958	92.945	6.400	32.00	22.90	25,922	113,180	
2.233	.879	$\frac{1}{29}$	5.150	79.476	6.216	31.08	16.52	18,703	60,181	
2.423	.954	$\frac{1}{26}$	6.825	105.324	7.276	36.38	18.60	21,051	57,867	
3.529	1.389	$\frac{1}{18}$	9.441	155.695	6.466	32.33	12.127	13,724	42,462	
2.750	1.0826	$\frac{1}{23}$	7.616	117.531	4.074	20.37	20.285	18,237	89,527	
2.515	.990	$\frac{1}{25}$	5.400	83.334	6.774	33.87	13.65	15,460	45,645	
1.844	.726	$\frac{1}{35}$	5.083	78.442	6.608	33.04	23.917	27,070	82,120	
2.162	.8512	$\frac{1}{29}$	4.908	76.741	7.800	39.00	16.80	19,011	48,755	
2.423	.954	$\frac{1}{26}$	5.416	83.581	6.576	27.88	14.76	16,705	59,920	
1.8045	.710	$\frac{1}{36}$	5.491	84.83903	6.658	33.29	26.996	30,554	91,782	
2.327	.916	$\frac{1}{28}$	5.233	80.75748	5.958	29.79	15.462	17,500	58,746	
1.920	.756	$\frac{1}{33}$	6.866	105.95841	4.324	21.62	29.80	33,728	156,000	
2.522	.993	$\frac{1}{26}$	7.883	121.6532	7.316	36.58	19.83	22,443	61,388	
2.210	.870	$\frac{1}{29}$	4.750	73.303	5.832	29.16	15.56	17,611	60,397	
2.4015	.945	$\frac{1}{26}$	7.258	112.00798	6.224	31.12	20.144	22,799	73,263	
2.2125	.8710	$\frac{1}{29}$	8.583	132.45584	7.674	38.37	28.082	31,784	82,835	
1.816	.715	$\frac{1}{35}$	5.391	83.2957	5.500	27.50	26.155	29,602	107,640	
2.1145	.832	$\frac{1}{30}$	5.258	81.14328	7.040	35.20	39.78	45,030	127,920	
1.943	.765	$\frac{1}{33}$	4.475	69.059	5.524	27.62	18.96	21,465	77,745	
2.1145	.832	$\frac{1}{30}$	7.725	119.2048	6.592	32.96	25.24	28,575	86,708	
1.9645	.773	$\frac{1}{33}$	8.525	131.56107	7.150	35.75	35.34	40,002	111,890	
1.907	.7508	$\frac{1}{34}$	5.758	88.85945	6.482	32.41	25.33	28,672	88,467	
2.261	.890	$\frac{1}{28}$	6.608	101.876	7.074	35.37	20.68	23,407	66,180	
2.065	.813	$\frac{1}{31}$	5.133	79.2142	5.574	27.87	19.25	21,800	78,215	
1.921	.756	$\frac{1}{33}$	2.708	41.790	5.324	26.62	11.74	13,288	49,920	
1.527	.601	$\frac{1}{42}$	3.466	53.4885	5.982	29.91	23.78	26,918	89,997	
2.345	.923	$\frac{1}{27}$	7.150	110.3412	6.090	30.45	20.80	23,542	77,325	
2.134	.840	$\frac{1}{30}$	5.756	88.828	5.332	26.66	20.22	22,888	85,857	
2.544	1.0014	$\frac{1}{25}$	5.925	92.436	5.782	28.91	14.64	16,575	57,349	
2.124	.836	$\frac{1}{30}$	5.200	80.248	5.882	29.41	18.44	20,872	70,970	
2.096	.825	$\frac{1}{31}$	5.525	85.264	5.316	26.58	20.12	22,772	85,681	
1.847	.727	$\frac{1}{34}$	7.233	111.6222	7.416	37.08	33.89	38,395	103,547	
2.0535	.8084	$\frac{1}{31}$	4.950	77.389	7.832	39.16	18.79	21,267	53,073	
1.923	.757	$\frac{1}{33}$	5.725	88.35019	4.824	24.12	24.770	28,035	116,234	
1.382	.544	$\frac{1}{47}$	4.691	72.493	4.600	23.00	39.29	44,475	193,385	
2.059	.8106	$\frac{1}{31}$	5.875	90.664	6.674	33.37	22.17	25,095	75,203	
2.189	.862	$\frac{1}{29}$	6.708	103.52	6.540	32.70	22.37	25,325	77,455	
2.474	.974	$\frac{1}{26}$	4.616	71.235	4.540	22.70	12.066	13,345	58,793	
1.958	.771	$\frac{1}{33}$	3.583	55.294	5.824	29.12	14.93	16,898	58,031	
1.870	.736	$\frac{1}{34}$	6.110	94.291	6.250	31.25	27.95	31,640	101,250	
1.921	.756	$\frac{1}{33}$	4.758	73.427	6.350	31.75	20.677	23,348	73,539	
2.728	1.074	$\frac{1}{24}$	6.750	104.168	6.800	34.00	14.51	16,425	48,309	
2.071	.8154	$\frac{1}{31}$	5.756	88.828	5.332	26.66	21.47	24,305	91,155	
2.007	.790	$\frac{1}{32}$	4.841	74.708	4.950	24.75	16.41	18,582	75,081	
1.956	.770	$\frac{1}{33}$	5.133	79.114	6.070	30.35	21.51	24,355	80,235	
2.4396	.960	$\frac{1}{26}$	7.200	111.112	5.940	29.70	19.361	21,917	73,798	
1.540	.610	$\frac{1}{42}$	4.466	68.930	7.116	35.58	30.129	34,101	95,844	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
NEW YORK—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Osborn & Ladd, Victor ..	4670	21	Shropshire Merino.	Ewe	1 yr.....	.....	8 5	4
Do.....	4655	22	.....do	....do ...	2 yrs....	.....	6 12	3.75
Do.....	4654	23	.....do	Ram....	1 yr.....	.....	7 10	3.75
Do.....	4669	24	.....do	....do ...	3 yrs....	.....	7 5	4
A. Boardwell, Fargo	4656	25	Oxfordshire Merino.	Ewe	1 yr.....	.....	9 8	5
Do.....	4671	26	.....do	....do ...	5 yrs....	.....	11 12	5.25
Do.....	.....	27	.....do	Ram....	1 yr.....	.....	9 7	5.75
Do.....	4672	28	.....do	....do ...	2 yrs....	.....	11 12	4.50
Jas. Wood, Mount Kisco .	4609	29	Hampshire Down.	....do ...	3 yrs....	.....	6 13	4
Do.....	.....	30	.....do	....do ...	1 yr.....	.....	9 12	4
Do.....	4666	31	.....do	Ewe	3 yrs....	.....	6 12	3
Do.....	4650	32	.....do	....do ...	1 yr.....	.....	9 1	5
J. Hobart Warren, Hoosic Falls.	4652	33	Southdown...	Ram....	2 yrs....	.....	6 0	2.75
Do.....	4667	34	.....do	....do ...	1 yr.....	.....	8 0	4.50
Do.....	4668	35	.....do	Ewe	2 yrs....	.....	7 4	3.75
Do.....	4653	36	.....do	....do ...	1 yr.....	.....	6 12	4.50
Van Duser Bros., Cobleskill.	4639	37	Cheviot	Ram....	.....	.....	17 0	7.50
Wm. Curry, Hartwick...	4642	38	.....do	Ewe	1 yr.....	.....	6 3	7.50
Do.....	4649	39	.....do	....do ...	2 yrs....	.....	7 9	6.50
Do.....	4648	40	.....do	Ram....	2 yrs....	.....	8 9	4.50
Do.....	.....	41	.....do	....do ...	2 yrs....	.....	8 6	5.50
John Clucks, Attica.....	4644	42	Cotswold	Ewe	11 mos..	.....	9 13	10.50
Do.....	4643	43	.....do	....do ...	3 yrs....	.....	15 11	8.50
Do.....	4645	44	.....do	Ram....	1 yr.....	.....	14 8	8.50
Do.....	641	45	.....do	....do ...	2 yrs....	.....	18 8	10.25
J. M. Ham, Washington Hollow.	4640	46	Dorset Horn..	....do ...	2 yrs....	.....	7 2	4
Do.....	4608	47	.....do	....do ...	1 yr.....	.....	6 5	4
Do.....	4646	48	.....do	Ewe	3 yrs....	.....	5 6	3
Do.....	4647	49	.....do	....do ...	1 yr.....	.....	6 15	5
NORTH CAROLINA.								
Holt & Hornewood.....	24605	.....	Southdown...	.....	.....	.....	.....	4
Do.....	24606	.....	.....do	.....	.....	.....	.....	5.50
Do.....	24607	.....	.....do	.....	.....	.....	.....	5
Do.....	24608	.....	.....do	.....	.....	.....	.....	4.50
Do.....	24609	.....	.....do	.....	.....	.....	.....	2.50
Do.....	24610	.....	Oxfordshire Down.	.....	.....	.....	.....	5.50
Do.....	24611	.....	.....do	.....	.....	.....	.....	5
Do.....	24612	.....	.....do	.....	.....	.....	.....	5.50
Do.....	24614	.....	Worcester	.....	.....	.....	.....	6.50
Do.....	24615	.....	.....do	.....	.....	.....	.....	5
Do.....	24616	.....	.....do	.....	.....	.....	.....	3.75
Do.....	24617	.....	.....do	.....	.....	.....	.....	5.75
OHIO.								
R. C. Moulton	.....	0	Rambouillet..	Ram....	2 yrs....	.....	15 4	2.45
Do.....	.....	1	American Merino.	....do ...	4 yrs....	137	22 7	2.25
J. D. Irwin, Ada.....	.....	2I	.....do	Ewe	4 yrs....	100	16 3	2.25
S. M. Brocaw, New Athens	.....	2	Black-top	....do ...	3 yrs....	100	6 7	2.43
S. D. Irwin, Ada.....	.....	3I	American Merino.	....do ...	3 yrs....	90	18 8	2
Do.....	.....	3	Delaine.....	Ram....	2 yrs....	150	18 0	2.25
Do	.....	4	American Merino.	....do ...	4 yrs....	120	20 2	2.50
		5	Merino	....do ...	2 yrs....	109	17 2	2.25
Do.....	.....	6	American Merino.	....do ...	3 yrs....	124	20 10	2.75
A. D. Dunn, Ada	.....	7	.....do	Ewe	3 yrs....	93	15 0	2.75
Do.....	.....	8	Merino	....do ...	2 yrs....	81	14 8	2.25
Do.....	.....	9	American Merino.	....do ...	2 yrs....	80	13 12	9

of tests of individual samples of wools—Continued

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2} = \frac{R}{E}$		Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.			
2.697	1.062	1/24	12.875	198.69	5.400	27.00	28.245	32,041	118,690
3.006	1.183	1/21	11.191	172.803	4.358	21.79	19.81	22,420	102,900
2.624	1.033	1/24	10.125	156.25	4.850	24.25	23.51	26,609	109,728
3.343	1.316	1/18	14.450	178.471	5.532	27.66	20.68	23,418	84,652
3.194	1.257	1/20	17.641	272.24	5.682	28.41	27.66	31,315	110,250
3.937	1.555	1/16	20.008	308.770	8.000	40.00	20.64	23,365	58,420
2.987	1.176	1/20	21.283	328.44	7.974	39.87	38.06	43,197	108,345
3.781	1.488	1/17	14.95	231.71	7.682	38.41	16.732	18,937	49,303
2.708	1.065	1/27	9.400	155.06	8.524	42.62	20.55	23,264	54,585
3.0035	1.182	1/17	14.85	236.10	6.440	32.20	26.26	29,710	80,360
2.7715	1.091	1/24	14.05	216.82	6.350	31.75	29.28	33,130	104,400
2.863	1.127	1/17	11.983	185.92	7.700	38.50	23.39	26,476	68,763
3.047	1.199	1/13	6.791	104.89	8.432	42.16	11.702	13,242	31,417
2.5885	1.019	1/21	7.166	110.58	6.774	33.87	17.11	19,368	57,184
3.090	1.216	1/21	8.766	135.277	8.732	43.66	14.687	16,625	38,255
3.182	1.253	1/20	8.100	125.00	5.890	29.45	12.79	14,486	49,191
3.785	1.490	1/16	21.316	328.95	8.608	43.04	23.80	26,934	62,603
2.954	1.163	1/18	19.816	315.80	8.266	41.33	36.33	41,129	99,513
3.523	1.387	1/20	20.200	311.73	7.582	37.91	26.04	29,472	77,743
3.157	1.242	1/24	17.208	265.55	7.916	39.58	27.612	31,251	78,958
3.598	1.416	1/20	18.158	280.220	7.274	36.37	22.43	25,388	69,808
4.125	1.624	1/15	19.608	312.59	7.758	38.79	18.43	20,859	53,774
5.204	2.049	1/12	33.550	517.75	8.574	42.87	19.81	22,420	52,310
3.566	1.404	1/19	18.91	292.82	6.616	33.08	23.79	26,928	81,403
4.055	1.595	1/16	28.525	440.20	8.474	42.37	27.75	31,410	74,132
3.275	1.289	1/20	16.283	251.28	6.840	34.20	19.29	21,830	63,840
2.972	1.170	1/24	10.525	162.42	7.040	35.20	19.05	21,558	61,270
2.756	1.085	1/21	14.458	223.12	6.324	31.62	30.438	34,451	166,260
3.178	1.259	1/20	14.991	232.44	6.582	32.91	23.75	26,870	81,670
2.769	1.090	1/17	14.21	219.29	7.582	37.91	29.652	33,562	88,530
2.822	1.111	1/19	13.20	203.706	6.342	31.71	26.581	30,016	94,658
2.861	1.126	1/17	13.44	207.40	6.316	31.58	26.271	29,734	94,155
2.965	1.167	1/18	26.05	402.01	7.558	37.79	47.301	53,536	141,660
2.269	.893	1/115	10.633	164.19	6.590	32.95	33.085	37,390	113,420
3.805	1.498	1/17	18.566	286.51	6.232	31.16	20.511	23,214	74,477
2.452	.905	1/103	12.558	193.79	6.000	30.00	33.424	37,830	126,100
3.023	1.190	1/20	16.358	252.44	6.740	33.70	28.625	32,399	96,141
2.937	1.156	1/18	17.891	276.20	5.782	28.91	33.183	37,557	129,910
2.477	.975	1/103	11.375	175.54	7.674	38.37	37.327	42,247	110,100
2.782	1.095	1/15	14.675	226.46	6.782	33.91	30.286	34,278	101,110
3.389	1.334	1/19	17.250	270.06	7.283	36.41	16.361	18,526	84,057
2.464	.970	1/103	5.550	85.649	6.024	30.12	14.62	16,557	54,960
2.243	.883	1/113	6.456	99.631	4.750	23.75	20.55	23,260	97,931
1.959	.771	1/129	5.250	81.036	6.590	32.95	21.888	24,773	75,184
1.994	.785	1/127	5.850	90.279	6.882	34.41	23.54	26,640	77,430
2.487	.979	1/102	6.300	97.223	6.032	30.16	16.292	18,442	61,160
1.997	.786	1/127	5.000	77.161	6.500	32.50	20.06	22,704	70,004
2.129	.838	1/119	6.375	98.381	5.974	29.87	22.503	25,469	85,268
1.816	.715	1/139	5.066	78.180	6.090	30.45	24.57	27,815	91,355
2.258	.889	1/112	7.925	123.91	6.000	30.00	24.87	28,147	93,830
2.327	.916	1/109	4.916	76.865	6.050	30.50	14.528	16,440	54,348
2.700	1.063	3/28	6.316	97.470	5.750	28.75	13.86	15,689	54,572
2.5855	1.018	3/29	6.358	98.118	6.308	31.54	15.22	17,229	54,609

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.		Corrected length of fiber in crimp.
OHIO—continued.						*Pounds.*	*Lbs.*	*oz.*	*Inches.*
S. D. Irwin, Ada		10	American Merino.	Ewe	1 yr.	60	17	6	1.45
A. H. Dean		11	Merino	Ram	2 yrs.		23	4	2.50
		128					34	10	11.68
J. N. Carpenter, Batesville.	2302		Delaine Merino.	Ram	3 yrs.		12	13	
Do	2330		Merino	Lamb	395 dys.		4	14	2.76
Do	2906		Black-top and National Delaine.	Ewe	2 yrs.		5	2	2.75
Brown & Osetaby, Springfield.	5036		do	do	3 yrs.		10	10	3.08
H. D. Dodge, Dodgeville	5036		Cotswold	do	12 mos.		10	10	3.59
	5037								
S. Dodge, Dodgeville	5037		Cotswold	Ewe	12 mos.	118	11	1	8.27
H. D. Dodge, Dodgeville	5038		do	do	12 mos.		12	13	8.50
Do	5039		do	Ram	24 mos.		14	4	7
Do	5040		do	do	2 yrs.	240	15	8	6.50
	5042		Merino	do	2 yrs.		12	12	2.25
Thos. Love, Fairport	5044		National Delaine Merino.	do	3 yrs.		13	13	3.89
N. C. & T. Gillespie, Shepherdstown.	5050		do	Ewe	1 yr.		7	8	2.50
	5053		do	Ram	378 dys.	132	13	0	3.40
M. C. Long	5054		do	do	3 yrs.	175	13	5	2.57
M. C. Long, Champaign	5056		do	Ewe	3 yrs.	100	12	0	3
M. C. Long, Urbana	5057		do	do	3 yrs.	110	10	9	3.50
A. H. Jones, Delaware	5126a		Southdown	do	3 yrs.	110	5	12	2.42
Do	5126b		do	do	4 yrs.	100	5	4	3.70
C. Hill & Son, Delaware	5127		Shropshire	do	2 yrs.	159	8	2	3.69
Do	5128		do	do	2 yrs.	150	7	8	1.10
Do	5129		do	Ram	2 yrs.	205	10	10	5.17
Do	5130		do	do	2 yrs.	200	12	8	2.64
W. P. Perry, Radnor	5131		Black-top Merino.	do	3 yrs.		12	4	2.57
Chas. E. Davis, Radnor	5132		do	Ewe	1 yr.	96	8	3	3.08
H. P. Miller, Sunbury	5133		Delaine Merino.	Ram	2 yrs.	125	17	2	2.43
S. N. Ward, Delaware	5135		Oxfordshire	Ewe	4 yrs.	208	9	8	5.97
W. Richardson, Wauseon	5137		Cotswold	do			9	5	11
Do	5138		do	Wether			8	13	12.50
H. P. Miller, Sunbury	5139		Delaine Merino.	Ewe	5 yrs.		9	4	9.50
W. Richardson, Wauseon	5139		Cotswold	Wether	360 dys.	124	11	6	
E. J. Thwing, Chardon	5140		Oxford	Ewe	5 yrs.	197	8	1	3.70
Do	5142		do	do	5 yrs.	209	8	7	7.52
Do	5142		Merino	do	2 yrs.	90	8	9	2.38
R. B. Williamson, Xenia	5145		American Merino.	Ram	2 yrs.	135	16	14	1.50
Do	5146		Merino	Ewe	2 yrs.	117	12	2	2.25
Do	5147		do	do	2 yrs.	121	14	2	2
Do	5148		American Merino.	do	2 yrs.	115			3.65
J. C. Williamson, Xenia	5149		Oxfordshire	do	2 yrs.	240	10	4	5
Do	5150		do	Ram	2 yrs.	285	9	0	7.50
Do	5151		do	do	3 yrs.	300	11	7	3.50
Do	5152		do	Ewe	2 yrs.	250	9	2	3.50
D. H. Cherry & Son, Xenia	5153		Cotswold	do	2 yrs.	167	15	9	10
Do	5154		do	do	3 yrs.	180	12	8	7
Do	5156		do	do	11 mos.	110	5	7	2.57
D. B. & B. C. Watt, Xenia	5157		do	do	3 yrs.		16	11	10
Do	5158		do	do	23 mos.	175	12	7	8.41
A. Trumbull, Cedarville	5159		Delaine Merino.	Ram	2 yrs.	140	17	4	3.50
Do	5160		do	Ewe	2 yrs.	101	13	13	3.26
Do	5161		do	do	2 yrs.		13	12	3.26
Do	5162		do	Ram	4 yrs.	175	17	6	2.75
James Wilkins, Londonderry.	5163		Spanish Merino.	Ewe	2 yrs.		10	13	1.84
Do	5164		do	do	8 yrs.	84	12	8	2.11
Do	5165		do	do	2 yrs.		17	4	2.11
	5168		Merino	Ram	2 yrs.	96	13	11	2.11

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109\frac{S}{D^2} =$	$E = \frac{R}{P}$	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.		R.		
2.568	1.011	$\frac{1}{25}$	6.858	105.835	5.574	27.87	16.63	18,838	67,571	
2.3575	.928	$\frac{1}{1077}$	4.633	71.497	5.700	28.50	13.343	15,102	52,989	
3.3175	1.318	$\frac{1}{758}$	15.600	240.74	6.040	30.20	22.28	25,218	83,505	
1.646	.648	$\frac{1}{1542}$	4.758	73.427	6.290	31.45	17.729	20,065	63,802	
2.2635	.891	$\frac{1}{1122}$	4.533	69.955	6.774	33.87	14.16	16,025	47,325	
2.099	.826	$\frac{1}{1209}$	6.350	97.995	7.300	36.50	23.06	26,100	71,508	
3.866	1.520	$\frac{1}{658}$	20.850	321.76	8.550	42.75	22.32	25,260	59,090	
4.092	1.611	$\frac{1}{620}$	24.908	385.38	9.658	48.29	23.79	26,930	55,762	
3.8865	1.530	$\frac{1}{653}$	35.916	555.26	10.416	52.08	38.04	43,060	82,660	
3.780	1.488	$\frac{1}{671}$	30.100	464.51	9.682	48.41	13.16	38,150	78,805	
4.379	1.724	$\frac{1}{579}$	24.625	380.02	9.092	45.46	25.89	23,280	51,210	
2.370	.933	$\frac{1}{1071}$	5.966	93.069	5.582	27.91	16.994	19,234	68,916	
2.009	.791	$\frac{1}{1264}$	5.925	92.436	6.600	33.00	23.488	26,584	80,558	
2.2045	.868	$\frac{1}{1152}$	6.241	96.313	5.550	27.75	20.557	23,266	83,842	
3.3505	1.319	$\frac{1}{758}$	6.900	107.48	6.440	32.20	17.178	19,398	60,242	
2.4845	.978	$\frac{1}{1022}$	5.850	90.279	4.974	24.87	15.166	17,169	69,035	
2.324	.915	$\frac{1}{1092}$	6.033	93.003	6.940	34.70	17.831	20,228	58,294	
2.088	.822	$\frac{1}{1216}$	5.616	86.668	7.358	36.79	20.61	23,328	63,407	
2.970	1.169	$\frac{1}{855}$	11.116	172.22	6.150	30.75	20.15	22,800	74,170	
2.662	1.048	$\frac{1}{954}$	10.825	167.05	5.450	27.25	24.43	27,655	10,145	
3.505	1.380	$\frac{1}{724}$	17.125	264.37	7.774	38.87	22.29	25,238	65,075	
3.5715	1.406	$\frac{1}{711}$	19.241	306.92	8.524	42.62	24.14	27,325	64,110	
3.218	1.267	$\frac{1}{789}$	17.025	262.71	9.040	45.20	26.29	29,762	65,850	
2.9315	1.154	$\frac{1}{866}$	21.616	334.38	8.200	41.00	40.24	45,552	111,102	
2.202	.8669	$\frac{1}{1153}$	5.041	77.794	7.158	35.79	16.63	18,820	52,600	
2.619	1.031	$\frac{1}{969}$	5.191	80.193	6.650	33.25	12.10	13,704	41,217	
2.098	.826	$\frac{1}{1210}$	4.518	69.723	5.724	28.62	16.433	18,587	64,947	
3.917	1.542	$\frac{1}{648}$	32.300	498.46	6.366	31.83	33.680	38,120	119,750	
5.162	2.032	$\frac{1}{491}$	26.725	412.42	9.600	48.00	16.04	18,150	37,833	
3.295	1.297	$\frac{1}{770}$	24.150	372.79	9.908	49.54	35.59	40,281	81,310	
2.286	.900	$\frac{1}{1110}$	6.350	97.99	5.932	29.66	19.442	22,005	74,191	
3.478	1.396	$\frac{1}{730}$	29.700	468.34	8.900	44.50	39.28	44,461	99,918	
3.546	1.396	$\frac{1}{716}$	25.575	394.68	9.532	47.66	32.536	36,820	77,267	
3.480	1.370	$\frac{1}{729}$	24.350	375.77	9.316	46.58	32.17	36,412	78,168	
2.3955	.943	$\frac{1}{1080}$	7.083	109.307	7.000	35.00	19.757	22,361	63,890	
2.0955	.825	$\frac{1}{1212}$	6.466	99.788	6.924	34.62	23.571	26,672	77,061	
2.230	.878	$\frac{1}{1138}$	6.447	99.502	7.024	35.12	20.74	23,476	66,845	
1.808	.712	$\frac{1}{1404}$	6.208	95.804	3.808	19.04	30.38	34,292	18,027	
2.3525	.926	$\frac{1}{1079}$	6.058	93.489	7.808	39.04	17.50	19,815	50,763	
4.2675	1.680	$\frac{1}{595}$	26.608	400.62	8.208	41.04	23.42	26,507	64,590	
3.749	1.4759	$\frac{1}{677}$	26.29	405.816	7.750	38.75	29.92	33,871	87,410	
3.630	1.429	$\frac{1}{699}$	25.375	381.59	8.540	42.70	30.81	34,875	81,669	
3.2565	1.282	$\frac{1}{779}$	8.366	128.107	8.000	40.00	12.62	14,285	35,715	
3.957	1.5578	$\frac{1}{641}$	24.90	385.26	5.484	27.42	25.44	28,790	105,000	
3.955	1.557	$\frac{1}{642}$	32.316	498.71	9.308	46.54	33.05	37,415	80,383	
3.838	1.511	$\frac{1}{661}$	21.166	326.40	7.966	39.83	28.93	32,748	82,223	
4.046	1.593	$\frac{1}{627}$	47.966	741.22	9.500	47.50	46.87	53,055	111,695	
3.912	1.540	$\frac{1}{649}$	29.266	461.64	8.900	44.50	30.59	34,622	77,800	
2.055	.809	$\frac{1}{1235}$	5.186	80.032	5.632	28.16	19.648	22,238	78,971	
2.050	.807	$\frac{1}{1238}$	6.975	108.64	5.800	29.00	26.555	30,055	103,640	
1.9735	.777	$\frac{1}{1287}$	6.808	105.06	6.050	30.25	27.982	31,670	104,690	
1.996	.786	$\frac{1}{1272}$	5.966	93.06	5.316	26.58	23.954	27,111	102,000	
2.197	.865	$\frac{1}{1156}$	7.450	114.97	5.700	28.50	24.74	28,001	98,250	
2.121	.835	$\frac{1}{1197}$	6.958	108.37	7.932	39.66	24.74	28,009	70,622	
2.0065	.790	$\frac{1}{1266}$	6.441	93.399	6.432	32.16	25.61	28,985	90,109	
2.431	.957	$\frac{1}{1044}$	6.683	103.134	13.350	66.75	18.093	20,478	30,679	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
OHIO—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
R. L. Spencer, Salesville.	5169	.....	Atwood and Dickinson.	Ewe....	.....	.....	12 1	3.08
Do.....	5170	.....	Delaine Merino.	....do...	1 yr.....	.....	9 6	2.57
Do.....	5172	.....	.....do.....	Ram....	1 yr.....	.....	11 1	2.57
Clifford Holmes, Cadiz...	5185	.....	Black-top Merino.	Ewe....	3 yrs....	.....	7 15	2.50
B. Baxter & Son, Hopedale.	5188	.....	.....do.....	Ram....	2 yrs....	130	7 1	2.65
Henry McKeen, Cadiz...	5189	.....	National Delaine.	Ewe....	1 yr.....	.....	7 3	2
Samuel M. Dunlap, Cadiz	5192	.....	Wells and Dickinson.	....do...	1 yr.....	60	5 12	3
Simeon Smith, Tappan..	5198	.....	Merino.....	Ewe....	6 yrs....	.....	7 9	3
Do.....	5199	.....	.....do.....	....do...	10 yrs...	.....	6 9	3
Israel Thomas, Cadiz....	5200	.....	Spanish Merino.	....do...	1 yr.....	75	6 4	3.50
S. B. Jameson, Cadiz.....	5201	.....	.....do.....	....do...	13 mos...	.....	6 10	2.76
Chas. McHogg, Cadiz	5202	.....	Black-top Merino.	....do...	12 mos..	75	6 10	1.70
Do.....	5202	.....	Grade Merino.	....do...	5 yrs....	.....	6 1	3.16
W. C. Long, Urbana.....	5058	.....	National Delaine Merino.	....do...	3 yrs....	110	12 5	3.53
Do.....	5059	.....	.....do.....	....do...	2 yrs....	100	9 1	3.08
J. N. Silver, Urbana.....	5060	.....	.....do.....	....do...	2 yrs....	110	10 8	2.50
A. Howard, Fountain Park.	5061	.....	Rambouillet	....do...	2 yrs....	130	8 11	2.50
A. Howard, Champaign .	5062	.....	.....do.....	Ram....	2 yrs....	160	13 4	3.04
R. C. Moulton, Woodstock	5063	.....	French Merino.	Ewe....	5 yrs....	122	9 4	2.72
Do.....	5066	.....	Rambouillet..	Ram....	23 mos..	157	14 10	3.26
S. R. Baltin, Selma.....	5068	.....	Spanish Merino.	Wether.	22 mos..	88	14 7	2.72
Do.....	5069	.....	.....do.....	Ewe....	11 mos..	.....	9 1	2.17
Do.....	5070	.....	Merino.....	....do...	8 yrs....	77	12 9	2.45
Mary L. Deal, South Charleston.	5071	.....	American Merino.	....do...	2 yrs....	70	9 11	2.45
Do.....	5072	.....	.....do.....	....do...	4 yrs....	85	10 3	2.05
Thos. Thorp, South Charleston.	5073	.....	Delaine Merino.	Ram....	1 yr.....	80	9 6	3.75
Do.....	5074	.....	Merino.....	Ewe....	4 yrs....	78	9 0	3.08
Do.....	5075	.....	Delaine Merino.	Ram....	4 yrs....	.....	15 2	3.84
F. R. Murray, South Charleston.	5076	.....	Cotswold and Leicester.	....do...	1 yr.....	125	9 4	6.16
Do.....	5077	.....	.....do.....	....do...	1 yr.....	120	8 1	5.25
Do.....	5078	.....	Dickinson Merino.	....do...	2 yrs....	130	14 11	2.17
Do.....	5079	.....	Cotswold and Leicester.	Ewe....	1 yr.....	118	9 11	7
John M. Murray, South Charleston.	5080	.....	Shropshire and Leicester.	Ram....	11⅛ mos	100	10 14	4.63
Do.....	5081	.....	.....do.....	....do...	11⅛ mos	100	8 5	7
Darwin Price, South Charleston.	5082	.....	American Merino.	Ewe....	3 yrs....	.....	14 9	3.17
Brown & Osetaby, Springfield.	5083	.....	Black-top Delaine.	Ram....	1 yr.....	75	13 7	3.95
Do.....	5084	.....	Black-top and Merino.	Ewe....	3 yrs....	80	8 10	3.08
Do.....	5085	.....	Black-top and Spanish Merino.	....do...	3 yrs....	.....	13 15	3.59
Do.....	5087	.....	.....do.....	....do...	2 yrs....	.....	12 1	3.85
Robt. Pow, Salem.....	5088	.....	American Merino.	....do...	1 yr.....	.....	16 12	3.73
Do.....	5089	.....	.....do.....	....do...	11 mos..	.....	8 0	3.26
Do.....	5090	.....	.....	Ram....	1 yr.....	.....	13 8	1.90
Do.....	5091	.....	.....do.....	Ewe....	2 yrs....	80	10 1	3.26

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
1.946	.766	1/1305	5.108	78.72	5.932	29.66	21.581	24,426	82,350	
2.588	1.019	1/981	6.741	104.02	7.258	36.29	16.100	18,220	39,890	
2.205	.868	1/1151	6.225	96.06	6.824	34.12	20.485	23,185	67,953	
2.283	.899	1/1113	4.241	65.44	7.924	39.62	13.018	14,735	37,191	
1.8596	.732	1/1366	5.525	84.26	7.132	35.66	25.579	28,951	81,182	
2.220	.874	1/1144	6.408	98.89	7.282	36.41	20.803	23,546	64,668	
1.823	.718	1/1393	4.625	71.37	6.708	33.54	22.267	25,202	75,139	
2.068	.822	1/1216	5.908	92.17	6.332	31.66	21.682	24,539	77,510	
2.121	.835	1/1197	6.616	92.10	8.182	40.91	23.530	26,632	65,099	
1.956	.770	1/1298	5.775	89.121	7.874	39.37	24.150	27,334	69,429	
2.327	.916	1/1091	5.250	81.019	6.708	33.54	15.512	17,555	52,347	
1.615	.636	1/1572	5.025	77.547	7.808	39.04	30.82	34,882	89,360	
2.4585	.968	1/1033	6.083	93.874	6.266	31.33	16.10	18,235	58,190	
2.017	.794	1/1259	5.241	80.680	7.374	36.87	20.61	23,325	63,275	
2.215	.872	1/1147	4.116	63.519	6.532	32.66	13.42	15,195	46,531	
2.1565	.849	1/1177	5.641	87.063	7.816	39.08	19.40	21,968	56,205	
2.187	.861	1/1161	4.583	69.725	5.932	29.66	15.33	17,356	58,500	
2.1105	.831	1/1203	4.300	66.359	5.524	27.62	15.45	18,738	64,795	
1.8445	.726	1/1377	4.416	68.148	6.950	34.75	20.76	23,508	67,645	
2.078	.818	1/1222	4.600	70.988	5.840	29.20	17.04	19,290	66,064	
2.087	.802	1/1246	6.900	10.748	6.140	30.70	26.606	30,113	98,089	
2.0445	.805	1/1243	4.950	77.390	7.024	35.12	18.956	21,455	61,093	
2.047	.806	1/1240	6.341	97.856	5.932	29.66	25.353	28,695	96,748	
2.3215	.914	1/1094	6.791	104.901	6.650	33.25	20.17	22,820	68,650	
2.2655	.892	1/1121	5.541	85.510	5.308	26.54	17.281	19,558	73,696	
1.9405	.764	1/1309	4.450	68.673	6.190	30.95	18.918	21,411	69,181	
2.494	.982	1/1018	6.675	103.010	6.924	34.62	17.17	19,433	56,134	
2.2455	.884	1/1131	6.508	100.433	6.690	33.45	20.66	23,383	69,906	
3.3605	1.323	1/756	17.983	277.74	8.658	43.29	25.41	28,760	66,435	
2.891	1.138	1/878	13.266	204.72	7.974	39.87	25.97	28,782	72,053	
2.2045	.868	1/1152	5.775	89.121	6.782	33.91	19.02	21,528	63,485	
3.150	1.240	1/806	17.816	274.94	9.050	45.25	34.09	38,588	85,280	
3.017	1.209	1/827	16.216	250.250	7.932	39.66	28.49	32,250	81,310	
3.363	1.324	1/755	19.125	305.143	7.832	39.16	27.03	30,610	78,172	
2.5125	.989	1/1011	10.883	167.950	7.840	39.20	27.58	31,225	79,652	
1.890	.744	1/1343	5.633	85.980	8.216	41.08	25.23	28,508	69,515	
1.796	.707	1/1414	5.591	86.462	7.924	39.62	27.73	31,390	79,225	
2.0805	.819	1/1221	6.316	97.470	7.808	39.04	23.358	26,437	67,727	
1.7225	.678	1/1474	6.541	100.94	7.532	37.66	35.29	39,945	106,000	
2.253	.887	1/1127	7.483	115.47	6.286	31.43	18.369	20,790	66,149	
2.220	.874	1/1144	4.783	73.812	6.840	34.20	15.171	17,174	50,218	
2.368	.932	1/1072	6.783	104.67	5.458	27.29	19.352	21,905	80,269	
1.943	.765	1/1307	6.766	104.41	6.440	32.20	28.675	32,454	108,000	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.		Corrected length of fiber in crimp.
OHIO—continued.									
						Pounds.	*lbs.*	*oz.*	*Inches.*
Robt. Pow, Salem	5092		Merino	Ram	2 yrs	160	13	10	3.25
Do	5093		do	Lamb	11 mos.	90	9	1	2.17
Do	5094		do	Ewe	8 yrs.	90	13	10	1.90
Do	5095		American Merino.	do	2 yrs.		9	6	2.99
Do	5097		do	do		85	12	5	1.60
M. H. Cranford, Roscoe	5098		Merino	Wether	3 yrs.		9	8	2.89
Do	5099		do	do	3 yrs.	90	9	13	2.94
Do	5100		do	Ewe	2 yrs.	85	11	7	2.89
Do	5101		Pure Merino	Wether	2 yrs.	95	9	3	3.96
Do	5102		do	do	3 yrs.	90	9	4	2.89
Rdt. B. Crouch, Tyrone	5104		Dickinson Delaine.	Ewe	3 yrs.		9	13	2.11
Do	5105		Delaine Merino.	Ram	5 yrs.	90	16	15	2.72
Wm. Martin, Mound	5113		Merino	Wether	2 yrs.	95	12	8	2.89
Davis Martin, Mound	5116		do	Ewe	2 yrs.	90	9	15	2.60
Do	5117		do	Wether	2 yrs.	95	9	9	3.96
James Atkinson, Galion	5120		Delaine Merino.	Ewe	11 mos.	70	8	12	2.50
Wesley Bishop, Delaware.	5121		Merino	do	5 yrs.	111	13	12	2.64
Do	5122		do	Ram	6 yrs.	148	16	7	2.38
Do	5123		do	Ewe	1 yr.	98	12	4	1.85
Do	5125		do	Ram	321 dys		10	2	3.36
Do	5124		do	Ewe	4 yrs.	110	16	1	2.33
John Martin, Sr., Georgetown.	5203		Grade Merino	do	1 yr.		5	10	2.91
Same McHagden	5205		Black-top Merino.	do	375 dys		7	8	2.43
John Adams, Jaceyville	5206		Merino Black-top grade.	Ewe	3 yrs.	105			
John Blair	5207		do	do	12 mos.	71	5	15	3.50
Walter Craig, Georgetown.	5208		National Delaine.	do	3 yrs		7	7	3
Do	5208		Delaine Merino.	do	2 yrs.	95	7	7	2.50
S. H. Todd & Son, Wakeman.	5218		Shropshire	do	2 yrs.	140	8	13	2.50
James Atkinson, Galion	5219		do	Ram	11½ mos.		8	4	4.76
Do	5220		do	Ewe	1 yr.	105	8	6	4.50
Alvin Crittenden, New London.	5221		Merino Standard Delaine.	do	3 yrs.	125	13	7	3.25
Do	5222		Delaine Merino.	Ram	3 yrs.	173	15	13	4
G. S. Thomas, Greenwich	5223		Merino	Ewe	2 yrs.	87	15	1	2.64
Do	5224		do	do	4 yrs.	85	16	2	2.64
D. O. Frayer, Greenwich	5226		do	do	5 yrs.	90	13	5	2.50
Do	5227		do	do	4 yrs.	83	10	14	1.50
Do	5228		do	do	4 yrs.	80	10	12	3.34
Do	5229		do	do	2 yrs.	93	11	8	2
Do	5230		do	do	3 yrs.	89			2.82
Do	5231		do	do	4 yrs.	91	4	14	2.76
M. H. Hawkins, Grunnock.	5232		do	do	3 yrs.	84	12	10	1.90
Do	5233		Black-top Merino.						
Do	5234		Merino	Ewe	4 yrs.		3	10	1.70
James Atkinson, Galion	5219		Shropshire						
Thos. McElroy, Bloomdale.	5326		Black-top	Ram	13 mos.		6	12	2.30
	5238		Delaine Merino.	Ewe	2 yrs.	125	12	12	3.26
Uriah Cook, West Mansfield.	5239		Merino	Ram	375 dys.	110	17	1	2.67
Do	5239								
Do	5240		Merino	Ewe	1 yr.	110	11	3	2.96
E. J. Thwing, Chardon	5241		Shropshire	do	2 yrs.	130	7	7	3.25
B. F. Harris, Chardon	5245		do	Ram	2 yrs.	220	10	3	4
Do	5246		do	Ewe	2 yrs.	128	15	8	3.50
B. F. Harris, Liberty	5247		do	do	2 yrs.		7	7	3.50

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2} =$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.		R.		
2.0425	.804	1/32	5.608	86.544	6.050	30.25	21.518	24,355	80,512	
2.106	.829	1/32	5.078	78.29	6.800	34.	18.30	20,725	60,944	
2.205	.868	1/32	6.650	102.62	6.408	32.04	21.934	24,774	77,304	
2.2635	.891	1/32	7.333	113.16	6.266	31.33	22.91	25,930	82,762	
2.014	.793	1/32	8.116	125.24	6.282	31.41	32.01	36,236	115,350	
2.233	.879	1/32	5.575	86.035	7.290	36.45	17.888	20,246	69,929	
2.163	.851	1/32	5.725	88.350	7.208	36.04	19.59	22,178	61,543	
2.276	.896	1/32	5.058	78.056	6.974	34.87	17.52	17,685	50,709	
1.925	.758	1/32	5.750	88.735	7.516	39.58	24.82	28,100	70,990	
2.068	.814	1/32	5.566	85.896	7.140	35.70	20.82	23,568	66,020	
2.271	.894	1/32	5.225	80.634	6.690	33.45	16.21	18,345	54,848	
2.347	.924	1/32	5.791	89.468	6.316	31.58	16.82	19,040	60,288	
1.456	.967	1/32	5.791	89.468	6.584	32.92	15.36	17,385	52,815	
2.220	.874	1/32	7.058	108.02	7.992	39.96	22.91	25,932	64,900	
2.027	.798	1/32	5.700	87.96	7.750	38.75	22.19	25,120	64,832	
1.918	.755	1/32	5.741	88.134	8.024	40.12	24.97	28,261	70,440	
2.200	.866	1/32	5.308	81.914	6.424	32.12	17.543	19,860	61,830	
1.819	.716	1/32	5.450	84.006	5.732	28.66	26.354	29,828	77,324	
1.9105	.752	1/32	5.708	88.087	5.836	29.18	25.034	28,334	97,101	
1.961	.772	1/32	4.458	68.795	4.840	24.20	18.126	20,515	84,774	
2.195	.864	1/32	9.166	151.45	5.840	29.20	30.438	34,451	117,980	
2.243	.883	1/32	5.200	80.248	6.840	34.20	16.537	18,717	54,728	
1.7275	.680	1/32	4.775	73.689	6.574	32.87	25.615	28,992	88,202	
2.136	.841	1/32	5.091	78.666	6.782	33.91	17.853	20,206	59,589	
1.727	.680	1/32	5.083	78.44	7.388	36.94	27.268	30,862	83,547	
2.299	.906	1/32	7.233	111.622	8.374	41.87	21.895	24,781	59,287	
2.431	.957	1/32	6.708	103.520	7.500	37.50	18.161	20,555	54,813	
3.193	1.257	1/32	19.84	316.17	7.216	36.08	31.135	35,240	99,030	
3.218	1.267	1/32	12.42	191.66	7.574	37.87	15.24	17,250	45,550	Unwashed.
2.835	1.116	1/32	14.90	230.94	7.490	37.45	29.66	33,571	89,641	
2.1135	.832	1/32	6.325	97.609	6.400	32	22.15	25,070	78,343	
1.999	.787	1/32	5.833	90.016	7.590	37.95	23.355	26,433	69,654	
1.9485	.767	1/32	5.283	81.529	7.008	35.04	22.27	25,210	71,950	
2.1615	.851	1/32	7.550	116.51	8.332	41.66	25.86	29,275	70,275	
2.350	.925	1/32	6.775	105.56	7.774	38.87	19.62	21,710	57,150	
2.1695	.854	1/32	6.450	99.53	7.982	39.91	21.93	24,829	62,210	
1.844	.726	1/32	5.608	86.550	8.350	41.75	26.38	29,868	71,538	
2.2635	.891	1/32	6.408	98.890	7.716	38.58	20.02	22,659	58,733	
2.4815	.977	1/32	6.708	103.52	6.940	34.70	17.43	19,733	56,870	
2.939	1.157	1/32	10.116	156.013	7.042	35.21	18.727	21,195	60,197	
1.646	.648	1/32	5.507	84.97	7.966	39.83	32.522	36,808	92,414	
1.6585	.653	1/32	3.483	53.750	6.516	32.58	20.272	22,903	70,299	
3.2995	1.299	1/32	15.22	234.88	7.358	36.79	22.37	25,325	68,835	Washed.
2.248	.885	1/32	5.600	86.30	6.408	32.04	17.730	20,067	62,629	
2.1385	.842	1/32	7.716	119.07	6.792	33.96	27.008	30.568	90,012	
2.055	.809	1/32	5.441	83.96	5.282	26.41	20.709	23,439	88,548	
2.243	.883	1/32	4.975	77.77	6.940	34.70	15.821	17,907	51,606	
2.271	0.894	1/32	11.400	175.82	6.590	32.95	35.366	40,028	121,480	
4.4855	1.766	1/32	18.960	292.44	6.924	34.62	15.073	17,060	49,277	
4.028	1.586	1/32	26.208	403.45	6.566	32.83	25.837	29,242	89,073	
3.607	1.420	1/32	15.91	246.52	6.250	31.25	19.56	22,140	70,860	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.		Corrected length of fiber in crimp.
OHIO—continued.						*Pounds.*	*Lbs.*	*oz.*	*Inches.*
E. W. Burgham, Ellsworth.	5248		Merino	Ewe	1 yr.		6	12	2.25
Do	5249		do	do			9	12	1.75
Do	5252		do	do	5 yrs	65	11	8	3
Do	5253		do	Ram	6 yrs	140	15	3	3
Do	5254		do	Ewe	2 yrs		9	4	2.50
Do	5256		do	Ram	2 yrs	140	14	0	3.00
Do	5257		do	Ewe	2 yrs	70	9	13	2.75
M. H. Rhoads, Cochranton.	5258		Delaine Merino.	do	2 yrs		12	13	3.26
Do	5259		Spanish Merino.	do	2 yrs		14	1	3.53
Do	5260		Merino	Ram	2 yrs	160	19	3	3.30
G. W. Walters, Marion	5261		Spanish Merino.	Ewe	4 yrs	98	10	9	2.80
Do	5262		do	Wether	3 yrs	186	10	3	3.93
E. B. Brewer, Marion	5263		Shropshire	Ewe	12 mos	95	8	11	4
Do	5264		do	do	12 mos		13	4	3.54
Amos Taylor, Morral	5265		French Merino.	Ram	5 yrs	210	13	3	3.04
Taylor & Nashburn, Morral.	2266		do	Wether	3 yrs	160	16	5	4.35
E. Brown, Morral	5267		do	Ewe	3 yrs	120	16	10	3.04
J. C. Mooris, Larue	5269		Merino	Ram	2 yrs	148	19	13	2.60
W. R. Mooris, Larue	5270		Spanish Merino.	Ewe	6 yrs	129	12	12	2.72
G. S. Everett, Cochranton	5271		Merino	do	2 yrs		10	7	2.50
B. Cusick, Marion	5278		Shropshire	do	390 dys	90	5	10	2.07
G. Rabo, Edison	5284		American Merino.	Ram	22 mos		14	6	1.60
G. T. Masters	5285		Spanish Merino.	Ewe	2 yrs	65	12	15	2
John W. Carpenter, Batesville.	5286		National Delaine.	do	13 mos		4	12	2.25
Do	5288								
Do	5292		Delaine Merino.	Ewe	3 yrs	102	11	3	3.75
Do	5293		do	do	2 yrs	90	8	8	3.17
Do	5294		do	do	3 yrs	98	11	10	2.50
Do	5295		do	do	1 yr	78	9	9	2.83
Do	5296		Delaine	Ewe	1 yr	80	10	6	2.30
Do	5297		Delaine Merino.	do	2 yrs	98	10	6	3
Do	5298		Delaine	Ram	2 yrs	100	3	8	2.50
Do	5299		do	do	1 yr	85	9	4	1.35
Do	5300		Delaine Merino.	do	3 yrs	155	17	4	2.75
Do	5301		do	do	1 yr	95	12	4	2.36
Do	5302		do	do	3 yrs	160	12	13	3
Do	5303		Delaine	do	3 yrs	145	12	0	3.50
Scott Holtz, Watson	5304		Dickinson	do	3 yrs	88	11	8	3.17
Do	5305		do	Ewe	3 yrs	97	13	5	3.43
John Holtz, Watson	5306		Black-top Merino.	do	380 dys	71	8	0	1.38
Do	5307		Black-top Spanish Merino.	do	2 yrs	764	8	5	3.34
Grattan & Baker, Melmore	5308		Delaine Merino.	do	350 dys		7	14	3.24
Chas. Rinebolt, Tiffin	5309		Shropshire	do	2 yrs	100	5	8	4.60
H. G. McDowell, Tiffin	5311		Dickinson	do	3 yrs		11	13	3.75
Do	5312		do	do	5 yrs	115	9	6	2.50
Do	5313		Delaine Merino.	do	2 yrs		10	15	3.50
Do	5314		do	do	2 yrs	90	9	4	3
Do	5315		Dickinson	do	1 yr		13	4	3
Do	5317		Merino	Ram			12	14	4
Do	5318		Delaine Merino.	Ewe	3 yrs		11	14	3
Do	5319		do	Ram	2 yrs	140	15	6	3.50
Do	5320		Dickinson	Ewe	3 yrs		13	12	3.50

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2 S.} =$	$18109 \frac{S}{D^2} =$	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.		R.		
1.994	.785	1/127	5.150	79.476	6.790	33.95	20.523	23,228	68,428	
2.0955	.825	1/121	5.641	87.053	6.008	30.04	43.061	48,760	162,310	
2.126	.837	1/119	6.583	101.59	4.028	20.14	23.30	26,370	130,900	
2.2375	.881	1/113	6.475	99.924	4.200	21	20.702	23,431	111,580	
2.215	.872	1/115	6.133	94.64	7.932	39.66	20	22,689	57,077	
2.4285	.956	1/105	8.525	131.56	7.716	38.58	23.137	26,181	67,877	
2.2325	.879	1/114	6.116	94.384	6.816	34.08	19.642	22,283	65,233	
2.164	.852	1/117	6.283	96.961	5.666	28.33	21.472	24,296	85,763	
2.1845	.860	1/116	6.258	96.57	7.074	35.37	20.992	23,758	67,172	
3.1675	1.247	1/81	9.208	152.101	5.582	27.91	15.381	17,408	62,373	
2.266	.892	1/112	6.641	102.48	6.424	32.12	20.74	23,421	72,917	
1.925	.758	1/132	6.750	104.16	7.624	38.12	29.144	32,986	86,533	
2.637	1.033	1/97	15.766	243.28	6.108	30.54	37.971	42,976	140,720	
2.563	1.009	1/99	16.850	259.033	7.144	35.72	41.04	46,451	130,042	
2.210	.870	1/115	5.508	84.97	7.016	35.08	18.04	20,428	58,202	
1.864	.734	1/136	5.083	78.276	7.300	36.50	23.40	26,492	75,582	
2.550	1.004	1/99	6.933	106.08	7.674	38.37	17.05	19,308	50,320	
2.4185	.952	1/105	5.583	85.991	6.566	32.83	15.27	17,295	52,671	
2.316	.912	1/109	4.825	74.460	5.432	27.16	14.392	16,289	59,977	
2.1185	.834	1/120	5.816	89.740	8.400	42	20.747	23,478	55,900	
3.332	1.312	1/76	13.216	203.95	7.740	38.70	19.037	21,547	66,938	
2.180	.858	1/116	6.400	97.76	6.116	30.58	17.115	19,371	66,346	
2.147	.845	1/118	5.666	87.316	6.250	31.25	19.666	22,259	69,607	
1.966	.774	1/129	6.133	93.644	7.232	36.16	25.387	28,734	79,464	
2.316	.912	1/109	7.991	125.41	7.274	36.37	23.83	26,975	74,170	
1.973	.777	1/128	5.141	79.337	8.658	43.29	21.13	23,910	55,248	
2.1615	.851	1/117	5.508	85.001	8.232	41.16	18.871	21,358	51,892	
2.263	.891	1/112	5.883	90.788	5.732	28.66	18.38	20,802	72,585	
2.1235	.836	1/119	6.200	95.680	7.790	38.95	21.99	24,895	63,925	
1.9535	.769	1/130	5.016	77.408	7.140	35.70	21.03	23,808	66,675	
1.966	.774	1/129	4.808	73.198	6.616	33.08	19.90	22,526	68,096	
2.177	.857	1/117	5.375	82.948	7.482	37.41	18.14	20,538	54,900	
2.0375	.802	1/125	5.191	80.096	6.142	30.71	20.062	22,654	73,770	
2.1795	.858	1/116	5.183	79.973	6.008	30.04	17.465	19,764	65,805	
2.0445	.805	1/124	5.050	77.921	6.816	34.08	19.339	21,999	64,227	
2.0115	.792	1/126	4.843	74.738	6.600	33	19.160	21,686	65,715	
2.1695	.854	1/117	5.766	88.959	6.508	32.54	19.655	22,194	68,207	
2.2025	.867	1/115	5.275	81.413	6.192	30.96	17.406	19,700	63,632	
1.994	.785	1/127	5.916	91.283	6.882	34.41	23.806	26,944	78,304	
2.256	.888	1/113	6.733	102.903	7.024	35.12	21.166	23,956	68,213	
1.819	.716	1/139	4.941	76.260	6.124	30.62	23.892	27,042	88,315	
4.539	.787	1/127	16.875	259.41	6.924	34.62	13.101	14,828	42,831	
1.9175	.755	1/133	5.533	85.374	7.700	38.50	23.219	26,279	68,259	
1.961	.772	1/130	4.950	76.389	6.416	32.08	20.595	23,309	72,662	
1.9535	.769	1/130	4.991	77.021	6.492	32.46	20.459	23,156	71,339	
2.0775	.818	1/122	4.658	71.783	6.624	33.12	17.276	19,553	59,038	
1.9105	.752	1/133	4.958	76.512	5.858	29.29	21.745	24,628	84,026	
1.839	.724	1/138	4.575	70.612	6.532	32.66	21.644	24,497	75,007	
2.1185	.834	1/120	5.550	85.149	7.200	36.00	19.795	22,404	62,234	
1.9965	.786	1/127	5.125	78.090	7.116	35.58	20.57	23,283	65,439	
2.184	.860	1/116	5.708	88.087	6.924	34.62	19.14	21,670	62,595	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.		Corrected length of fiber in crimp.
OHIO—continued.						*Pounds.*	*Lbs.*	*oz.*	*Inches.*
H. G. McDowell, Tiffin	5321		Delaine	Ram			16	13	
Do	5321		National Delaine.	do	3 yrs	150	16	13	2.75
Do	5322		do	do	3 yrs		18	4	3.50
Do	5323		Delaine Merino.	do	2 yrs	150	18	13	3
Do	5324		Native Dick	do	4 yrs		21	7	2.50
Do	5325		do	do	4 yrs		10	4	4
Asa Bates, Irwin	5328		Shropshire	Ewe	3 yrs	125	7	3	3
L. C. Dowell	5329		do	do	2 yrs		10	6	3.50
C. Hill & Son, Delaware	5329		do	do	2 yrs	200	10	16	4
Do	5330		Delaine Merino.	Ram	2 yrs	150	15	1	3.08
Wm. Staley, Marysville	5331		Spanish Merino.	Ewe	3 yrs	104	12	3	2.31
Do	5332		Delaine Merino.	do	3 yrs		11	15	2.72
H. P. Miller, Sunbury	5333		Shropshire	do	1 yr	150	10	1	
C. S. Chapman & Co., Marysville.	5334		Delaine	Ram	2 yrs	160	15	8	3.08
Do	5335		Spanish Merino.	Ewe	11 mos.		7	13	2.54
Do	5336		Delaine Merino.	do	2 yrs	102	9	8	1.45
Do	5250				5 yrs	110	16	1	2.33
OREGON.									
Cnas. Cunningham		2	Merino	Ram					2.50
R. Scott		3	Cotswold						10
M. Wilkins		4a	Oxfordshire		11 mos.				8
Do		4b	do		12 mos.				13.50
Do		4c	do		14 mos.				10.50
Do		4	Cotswold		12 mos.				7
R. Scott		4	Angora		1 yr.				12
Do		4	Oxford		11 mos.				8
Do		4b	do		11 mos.				
PENNSYLVANIA.									
James St. Iams, Swartz	6284	1	Delaine Merino.	Ewe	2 yrs.	85	6	1	2.50
James McCullam	6285	2	do	Ram	2 yrs.	160	12	14	2.50
James McCullam, Cannonsburg.	6286	3	do	do	2 yrs.	165	12	14	3.25
Do		4	do	Ewe	2 yrs.	110	16	0	3.25
Do	6286	5	do	do	2 yrs.	110	11	12	2.50
Do	6286	6	do	do	2 yrs.	110	11	6	3.50
James S. McNary, Cannonsburg.	6287	7	Pure Merino	Ram	2 yrs.	145	13	9	3
Do	6288	8	National Delaine Merino.	do	3 yrs.	160	12	4	2.50
Do	6288	8	do	do	3 yrs.	160	12	14	2.50
Do	6289	9	Delaine Merino.	do	4 yrs.	165	13	14	3.25
W. A. Herriot, Federal	6290	10	Pure Merino	Ewe	270 dys	60	13	12	3.32
Do	6291	11	Native Merino.	Ram	2 yrs.	160	9	4	3.34
Do	6292	12	Delaine Merino.	Ewe	2 yrs.	110	8	9	3.50
C. H. Beall, Independence.	6293	13	do	Ram	1 yr.		12	2	3.50
Do	6293	14	do	do	1 yr.		15	7	3.25
Do	6294	15	do	do	5 yrs.		10	14	3.75
Lee R. Scott, Burgettstown.	6294	16	Grade Merino	Ewe	406 dys	60	9	8	2.25
Do	6295	17	do	Ram		95	7	12	
Do	6296	18	Pure Merino	do	2 yrs.	135	12	12	4
James Glass, Burgettstown.	6297	19	do	do	85 dys	85	12	3	3.25
Do	6298	20	do	Ewe		80	7	14	

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S'}{D^2 S'} =$	$18109 \frac{S}{D^2} =$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.		R.		
2.236	.880	1/28	4.675	72.146	6.300	31.50	14.955	16,980	33,910	Washed.
1.654	.651	1/38	5.425	83.720	6.932	34.66	31.73	35,912	103,650	Unwashed.
1.977	.778	1/32	5.758	88.859	10.432	52.16	23.625	26,616	51,146	
1.860	.732	1/34	6.516	100.55	6.950	34.75	30.13	34,108	98,151	
1.862	.733	1/34	4.991	78.122	6.782	32.91	23.245	26,068	79,212	
1.737	.684	1/37	5.491	84.839	5.232	26.16	29.12	32,955	125,950	
3.145	1.238	1/20	20.58	317.59	7.008	35.04	32.522	37,678	107,530	
4.557	1.794	1/14	18.31	282.57	6.240	31.20	14.10	37,600	120,500	
3.661	1.441	1/17	17.68	262.84	6.566	32.83	21.105	23,887	72,762	
2.215	.872	1/28	4.791	74.036	8.358	41.79	15.624	17,683	42,315	
2.362	.930	1/27	6.408	98.890	7.724	38.62	18.377	20,799	52,631	
2.332	.918	1/27	6.250	96.452	7.400	37.00	18.385	20,812	56,248	
3.462	1.363	1/18	18.675	288.19	5.250	26.25	24.930	28,216	107,490	
2.281	.898	1/28	6.791	104.90	7.324	36.62	33.78	38,239	104,420	
2.172	.855	1/30	4.091	63.23	5.974	29.87	13.87	15,708	52,573	
2.208	.869	1/29	5.338	82.37	7.816	39.08	17.518	19,827	50,736	
2.196	.864	1/29	9.166	151.45	5.840	29.20	30.438	34,451	117,980	
2.205	.868	1/29	5.658	87.316	4.724	23.62	18.619	21,073	89,219	
3.904	1.537	1/16	21.38	329.94	6.924	39.62	22.444	25,402	80,717	
3.181	1.252	1/20	16.291	251.50	8.850	44.25	25.75	29,153	65,883	
4.019	1.582	1/16	23.67	365.28	8.082	40.41	23.44	26,535	65,670	Do.
3.800	1.496	1/17	22.86	352.78	8.116	40.58	25.92	28,665	70,645	
4.222	1.662	1/15	24.77	382.25	7.616	38.58	22.233	25,164	65,226	
2.820	1.110	1/23	22.96	355.32	8.732	43.66	46.194	52,283	151,100	
3.135	1.234	1/20	14.77	227.93	6.700	33.50	24.60	27,848	83,129	
3.445	1.356	1/18	21.97	340.04	8.608	43.04	29.61	33,523	77,885	Washed.
2.261	.890	1/28	7.550	116.51	8.716	43.58	20.58	23,293	53,450	
2.439	.960	1/26	7	108.026	5.916	29.58	18.827	21 309	72,039	
2.1245	.836	1/30	5.566	85.894	6.436	32.18	19.74	22,341	69,428	
2.3525	.926	1/27	5.325	82.177	8.550	42.75	15.401	17,431	40,775	
2.177	.857	1/30	6.250	96.451	7.174	35.87	21.10	23,880	66,578	
2.0631	.812	1/31	6.475	99.924	8.140	40.70	24.341	27,550	58,618	
2.403	.946	1/26	6.025	92.979	6.716	33.58	16.694	18,894	56,267	
2.063	.812	1/31	5.066	78.180	7.916	39.58	19.045	21,555	54,460	Unwashed.
1.809	.712	1/35	5.358	82.786	8.174	40.87	26.189	29,649	72,546	Washed.
2.4005	.945	1/26	5.383	83.072	5.924	29.62	14.952	16,923	57,136	
1.900	.748	1/33	5.483	83.072	7.6582	38.291	24.300	27,505	71,667	
2.3675	.932	1/27	7.700	118.82	7.916	34.58	21.98	24,877	71,943	
2.103	.828	1/31	4.933	77.126	4.140	20.70	17.846	20,198	97,579	
2.032	.800	1/32	5.616	86.668	6.066	30.33	21.760	24,630	82,210	
2.172	.855	1/30	6.616	102.100	7.100	35.50	46.611	18,800	52,960	
1.8605	.732	1/34	4.075	62.885	7.290	36.45	18.846	21,330	58,519	
2.161	.851	1/30	5.258	81.143	6.616	33.08	18.01	20,388	61,635	
										Missing.
2.0396	.8028	1/32	3.991	63.690	11.766	58.83	15.355	17,379	29,541	
2.271	.894	1/28	4.116	63.51	6.632	33.16	12.77	14,456	43,580	
										Do.

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
OREGON—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
James Glass, Burgettstown.	6299	21	Pure Merino..	Ewe	3 yrs....	90	13 4	2.75
Do.....	6299	21	.....	....do...	3 yrs....	90	10 0	.....
Do.....	6300	22	Pure Merino..	....do...	2 yrs....	85	13 0	3.50
SOUTH DAKOTA.								
E. L. Williams, Aurora...	24238	.....	Three-fourths Shropshire, one-fourth Merino.	....do...	2 yrs....	.....	23 4	5
T. E. Bushnell, Bushnell.	24239	.....	Shropshire Merino.	....do...	2 yrs....	.....	22 15	.....
Agricultural College, Brookings.	24240	.....	Shropshire ...	....do...	3 yrs....	.....	7 0	2
Do.....	24242	.....	One-half Shropshire, one-half Merino.	....do...	2 yrs....	.....	8 7	2.05
Do.....	24243	.....	Three-fourths Shropshire, one-fourth Merino.	....do...	2 yrs....	.....	4 14	4
Do.....	24244	.....	Dorset Horn..	Ram....	1¼ yrs...	.....	5 6	.....
Do.....	24245	.....	Shropshire Merino.	.....	.....	.....	7 14	3.08
Do.....	24246	.....	.....do.....	Ewe	3 yrs....	.....	6 8	3.50
Kreger Bros., Clear Lake.	24247	.....	Spanish Merino.	....do...	3 yrs....	.....	8 3	.....
O. O. England, Templeton.	24248	.....	Shropshire Merino.	....do...	3 yrs....	.....	8 15	2.31
Do.....	24249	.....	....do.....	....do...	2 yrs....	.....	7 11	5.14
J. B. Geddis, Virgil	24250	.....	One-half Shropshire, one-half Merino.	....do...	2 yrs....	.....	6 4	.....
Do.....	24251	.....	Three-fourths Shropshire, one-fourth Merino.	....do...	2 yrs....	.....	5 1	.....
H. B. Lathrop, Redfield ..	24252	.....	Dick. Delaine Merino.	Ram....	2 yrs....	.....	20 2	2.57
M F. Greely, Gary	24253	.....	Shropshire Merino.	Lamb ..	.....	.....	9 14	7.71
Agricultural College, Brookings.	24254	.....	.....do.....	Ram....	2 yrs....	.....	7 13	3.08
Robt. Scanan, Aurora....	24256	.....	One-half Merino, one-half Southdown.	Ewe	2 yrs....	.....	19 13	1.98
N. B. Gallup, Aurora.....	24257	.....	One-half Shropshire.	....do...	2 yrs....	.....	3 0	3.60
Do.....	24258	.....	Three-fourths Cotswold, one-fourth Shropshire.	....do...	6 yrs....	.....	3 5	3.60
D. Roberts & Son, Faulkton.	24259	.....	One-half Cotswold, one-half Shropshire.	....do...	2 yrs....	.....	4 0	4.11
Grant Ranch, Clear Lake.	24260	.....	One-half Shropshire, one-half Merino.	....do...	1 yr	.....	8 7	.....
James Flynn, Clear Lake.	24261	.....	Three-fourths Shropshire, one-fourth native.	....do...	2 yrs....	.....	8 7	3.25
Grant Ranch, Clear Lake.	24262	.....	Seven-eighths Shropshire, one-eighth Merino.	....do...	2 yrs....	.....	5 9	3.60

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109\frac{S}{D^2} = E = \frac{R}{P}$.			Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.		R.		
1.773	.698	1/1433	5.125	79.09	6.566	32.83	26.081	29,595	89,921	Unwashed.
2.108	.830	1/1205	5.258	81.143	6.516	32.58	18.93	21,420	65,765	Washed.
2.347	.924	1/1082	7.058	108.920	5.658	28.29	20.501	23,203	82,000	
1.944	.745	1/1342	7.741	119.461	5.140	25.70	32.773	37,093	144,330	
2.855	1.124	1/889	11.33	174.84	4.774	23.87	22.24	25,171	105,450	
4.026	1.585	1/631	12.925	199.46	6.482	32.41	12.75	14,435	44,539	
2.383	.938	1/1066	11.775	181.654	5.774	28.87	33.162	37,533	130,000	
3.348	1.318	1/759	14.416	222.47	6.008	30.04	20.17	23,266	76,529	
2.546	1.002	1/997	10.091	155.82	7.332	36.66	74.907	28,191	76,898	
2.840	1.118	1/894	12.666	196.35	5.966	29.83	25.11	28,425	95,289	
3.521	1.386	1/721	18.200	280.86	5.592	27.96	23.489	26,584	95,081	
1.887	.7429	1/1346	7.241	111.74	5.700	28.50	32.536	36,825	129,210	
2.257	.886	1/1128	7.400	114.19	5.958	29.79	23.36	26,447	88,780	
2.614	1.029	1/971	13.750	207.95	6.566	32.83	32.19	36,441	111,000	
2.868	1.129	1/885	8.975	139.50	5.516	27.58	17.458	19,759	71,643	
2.866	1.128	1/886	17.575	261.223	6.132	30.66	34.22	38,721	126,330	
2.141	.843	1/1186	6.175	95.294	7.508	37.54	21.5535	24,394	64,985	
2.853	1.233	1/810	21.675	334.49	6.508	32.54	48.236	48,211	148,160	
2.363	.930	1/1074	15.616	230.99	5.508	27.54	44.73	50,626	183,700	
2.124	.836	1/1196	9.975	164.93	6.674	33.37	35.377	40,040	119,990	
2.934	1.155	1/865	12.641	194.981	6.908	34.54	23.493	26,590	76,806	
2.632	1.036	1/964	13.475	207.95	4.182	20.91	31.12	35,222	168,460	
2.167	.853	1/1171	14.000	21.605	6.490	37.45	47.702	53,998	144,160	
3.054	1.202	1/831	10.125	156.24	5.800	29	17.36	19,659	67,789	
2.403	.946	1/1057	14.63	225.77	5.808	29.04	40.537	45,880	157,990	
2.317	.912	1/1096	9.900	163.78	6.208	31.04	29.50	33,395	107,550	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
SOUTH DAKOTA—cont'd.						*Pounds.*	*Lbs. oz.*	*Inches.*
Grant Ranch, Clear Lake.	24263	.....	Shropshire Merino.	Ewe....	2 yrs....	.....	6 1	3.34
N. B. Gallup, Aurora....	24264	.....	French Merino.	....do...	5 yrs....	.....	3 7	2.50
Edmund Cook, Wilmot..	24265	.....	Oxford dam ..	....do...	2 yrs....	.....	12 15	6
James McHough, Arlington.	24255	.....	Three-fourths Merino, one-fourth Cotswold.	....do...	2 yrs....	.....	12 15	2.57
D. B. Gallup, Wilmot....	24266	.....	Three-fourths Cotswold, one-fourth Merino.	....do...	1 yr.....	.....	3 11	3
Edmund Cook, Wilmot..	24267	.....	Oxfordshire dam.	Ram....	2 yrs....	.....	15 10	6
M. T. Lightner, Roscoe..	24269	.....	Three-fourths Merino and Lincoln.	Ewe....	2 yrs....	.....	6 9	1.28
Edmund Cook, Wilmot..	24268	.....	Oxfordshire dam.	....do...	3 yrs....	.....	12 4	.....
M. T. Lightner, Roscoe..	24270	.....	One-half Merino and one-half Cotswold.	....do...	3 yrs....	.....	6 9	.....
G. B. Milkamp, Roscoe..	24271	.....	One-half Merino and one-half Shropshire.	....do...	2 yrs....	.....	5 4	.....
F. M. Hopkins, Roscoe..	24272	.....	Three-fourths Cotswold.	Ram....	3 yrs....	.....	8 5	4.90
L. F. Gornson, Bushnell.	24273	.....	One-half Shropshire.	Ewe....	2 yrs....	.....	5 13	2.75
UTAH.								
Chas. Crane, Kanosh	5700	1	French Merino.	Ewe....	2½ yrs..	198	7 8	2.89
Do.....	.....	2	.....do.....	....do...	10 mos..	143	14 7	3.26
Agricultural College, Logan.	.....	3	Shropshire ...	Ram....	1 yr.....	.....	.....	.....
J. B. Hunter, Mount Pleasant.	.....	4	French Merino.	Ewe....	4 yrs....	.....	16 6	2.25
Do.....	.....	5	French Merino and Cotswold.	....do...	10 mos..	.....	.....	2.79
VERMONT.								
John I. Stickney, Whitney.	5539	1	Vermont Merino.	Ram....	4 yrs....	.....	16 7	2.50
C. L. Payne, Bridport ...	5540	2	.....do.....	Ewe....	2 yrs....	.....	.....	2
Do.....	5540	2	.....do.....	....do...	2 yrs....	100½	19 7	2.25
Do.....	5534	3	.....do.....	....do...	3 yrs....	97½	15 0	2.75
Ira L. Hamblin, Middleburg.	5536	4	.....do.....	Ram....	5 yrs....	.....	20 10	1.25
Do.....	5536	4	.....do.....	....do...	5 yrs....	.....	.....	.....
Do.....	5536	5	.....do.....	Ewe....	3 yrs....	92½	15 9	2.11
Albert Chapman, Middleburg.	5538	6	.....do.....	....do...	3 yrs....	107	14 5	2
Do.....	5538	7	.....do.....	....do...	7 yrs....	115½	16 12	2
C. A. Chapman, Ferrisburg.	5530	8	.....do.....	....do...	4 yrs....	.....	14 14	1.94
Do.....	5530	8	.....do.....	....do...	4 yrs....	.....	.....	.....
Do.....	5530	9	American Merino.	....do...	.....	.....	17 0	1.94
Lewis S. Burwell, Bridport.	5537	10	.....do.....	Ram....	2 yrs....	132	27 3	2.25
Do.....	5537	11	Vermont Merino.	Ewe....	5 yrs....	99½	16 5	2.34
Geo. N. Smith, Addison..	5533	12	.....do.....	Ram....	2 yrs....	.....	25 2	1.70
Do.....	5533	13	.....do.....	Ewe....	.....	.....	18 6	.....
Edgar Sanford, West Cornwell.	5532	14	.....do.....	....do...	3 yrs....	90	13 7	2.25

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2 R} =$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
2.939	1.157	1 1/8	12.80	197.58	5.732	28.66	23.709	26,835	93,632	
1.898	.747	1/1338	11.23	173.305	6.342	31.71	48.742	55,167	173,950	
3.267	1.286	1 7/7	14.58	224.23	7.022	35.11	21.781	24,652	70,215	
2.307	.908	1/1100	6.758	104.29	5.782	28.91	20.316	22,994	79,538	
2.614	1.029	1 1/1	11.613	179.21	5.542	27.71	27.18	30,769	111,039	
3.897	1.534	1 3/1	16.625	256.51	7.108	35.54	17.51	19,815	55,763	
2.185	.860	1/1163	8.108	125.12	5.074	25.37	27.17	30,756	121,225	
3.010	1.185	1 1/2	14.666	226.33	5.182	25.91	25.88	29,302	113,098	
2.261	.890	1/1123	7.758	119.72	6.158	30.79	24.327	27,482	89,255	
3.440	1.354	1 3/8	9.141	140.06	5.192	25.96	12.359	13,985	53,884	
3.028	1.192	1 1/4	13.050	201.39	6.708	33.54	22.773	25,774	76,847	
2.474	.974	1/1026	11.300	174.38	6.466	32.33	29.539	33,433	127,220	
2.3195	.913	1/1095	6.116	94.384	4.576	22.88	18.18	20.588	89,975	
2.116	.833	1/1200	5.291	81.758	5.416	27.58	18.903	21,394	77,575	
3.798	1.495	1 5/8	20.483	316.090	6.382	31.91	22.71	25,711	80,580	
2.125	.793	1/1260	10.733	165.63	5.408	27.04	42.29	47,870	177,060	
2.665	1.049	1 5/8	13.266	204.72	6.916	34.58	37.62	42,583	123,144	
2.088	.822	1/1216	4.416	68.149	4.816	24.08	16.20	18,342	76,174	
2.583	1.017	1 1/2	5.241	80.880	4.700	23.50	12.568	14,224	60,532	Washed.
2.292	.902	1/1108	5.716	79.882	7.900	39.50	17.41	19,700	49,880	Unwashed.
1.991	.784	1/1276	6.341	97.856	7.100	35.50	25.68	30,305	85,460	
2.535	.998	1/1002	6.216	95.927	4.532	22.66	15.476	17,516	77,301	Do.
2.347	.924	1/1082	5.108	78.828	4.358	21.79	12.715	14,394	66,058	Washed.
1.918	.755	1/1324	6.525	100.69	6.440	32.20	28.38	32,121	99,752	
1.880	.740	1/1350	4.841	74.708	7.832	39.16	41.20	46,630	94,590	
2.052	.808	1/1237	5.666	87.439	6.500	32.50	44.18	50,002	153,860	
2.146	.845	1/1183	5.941	92.683	5.358	26.79	20.64	23,361	87,201	Unwashed.
2.3875	.940	1/1063	5.710	88.118	5.558	27.79	16.02	18,140	65,276	Washed.
2.566	1.010	1 1/8	13.775	21.258	7.208	36.04	33.47	37,885	105,120	
2.454	.966	1/1034	19.016	303.452	6.850	34.25	50.50	57,164	166,900	
2.779	1.094	1 1/2	7.608	118.52	6.258	31.29	15.76	17,840	58,342	
3.023	1.190	1 1/4	8.774	135.40	6.408	32.04	15.361	17,386	54,265	
2.316	.912	1/1096	7.425	114.58	5.924	29.62	22.15	25,658	84,630	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
VERMONT—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
C. P. Crane, Bridport	5535	15	Vermont Merino.	Ewe	2 yrs	82		2
E. N. Bissell, East Shoreham.	5531	16	do	do	2 yrs	105	11 8	2.50
Do		25						
WEST VIRGINIA.								
W. P. & J. P. Whitham, West Alexander, Pa.	5426	5	Black-top Spanish Merino.	Ram	2 yrs		5 12	3.50
A. Wilson, Short Creek	5427	6	Delaine Merino.	do	2 yrs		7 12	2.50
Thos. H. Strain, Colliers	5428	7	Pure Merino	do	2 yrs		10 4	
P. A. Pugh, Fairview	5429	9	Pure Spanish Merino.	Ewe	5 yrs		8 5	
Do	5429	9	do	do	5 yrs		7 15	2.75
S. A. Cockyane, Moundsville.	5430	10	Pure Merino	do	2 yrs		7 14	2.50
A. A. Jacobs, Clinton	5425	11	Saxony Merino.	do	2 yrs		2 9	1.25
WISCONSIN.								
A. O. Fox, Oregon	3764	1	Pure-bred Shropshire.	Ewe	1 yr	160	10 9	4.25
Do		1b	do	do	1 yr			
Do	3763	2	do	do	1 yr	165	11 12	6
Do	3765	3	Shropshire Down.	do	11 mos	150		5.65
Do	3765	3	Pure-bred Shropshire.	do	11 mos			
Do	3766	4	Shropshire Down.	do	10 mos	150	11 12	5.98
Do	3767	5	do	do	1½ yrs	170	9 9	2.11
Do	3768	6	do	do	2 yrs	175	10 0	2.99
Do		7	do	do	11 mos	165	8 12	4.90
Do	3769	8	do	Ram	10 mos	170	12 4	5.98
Do	3770	9	Pure-bred Shropshire.	do	11 mos	185	13 0	4.35
Do	3771	10	do	do	1 yr	200	12 14	6.50
Do		11	do	do	10 mos	175	14 12	4.25
Do		12	do	do	12 mos	139	13 9	4.49
Do		13						
Arthur Broughton, Albany.	3754	14	do	Ram	3 yrs	280	10 8	3.60
Do	3755	15	do	Ewe	2 yrs	171	9 9	3.87
Do		16	do	do	1 yr	175	8 5	3.17
J. C. Payne, Prairie du Sac.	3820	17	do	do	10 mos	125	8 2	2.99
Do	3821	18	do	do	11 mos	135	9 8	3.26
Do	3822	19	do	Ram	11 mos	140		5.44
Do	3823	20	do	Ewe	1½ yrs	460	9 14	4.18
Do		21	do	do	23 mos	165	10 5	3.58
Do	3824	22	do	Ram	2 yrs	175	12 0	5.38
Geo. McKerrow, Sussex	3808	23	Southdown	do	2 yrs	181	9 2	2.99
Do	3809	24	do	do	1 yr	140	8 5	2.50
Do		25	do	do	1 yr	145	7 14	3
Do	3810	26	do	Ewe	4 yrs	160	7 5	3.36
Do	3811	27	do	do	1 yr	133	11 0	3
Do		28	do	do	1 yr	121	5 8	2.43
J. W. Gaines, Lowell	3825	29	Pure-bred Lincoln.	Ram	2 yrs	210	12 14	3.08
Do	3826	30	do	Ewe	2 yrs	168	12 1	6.68
Do		31	do	do	2 yrs	174	14 1	
Do	3827	32	do	Ram	393 dys	197	13 5	7.86
Do	3828	33	do	Ewe	306 dys	87½	7 2	8.56
Do	3829	34	do	do	364 dys	123	9 6	7.50
Geo. Hardings & Son, Waukesha.	3831	35	Cotswold	Ram	2 yrs	226	14 10	10.89
Do	3832	36	do	do	1 yr	160	17 14	13
Do	3833	37	do	do	11 mos	165	13 14	8.16
Do	3834	38	do	Ewe	3 yrs	180	15 3	10.34

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'}$	$18109 \frac{S}{D^2 R}$	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
2.3295	.917	1/1090	6.750	104.16	7.116	35.58	19.910	22,535	63,336	
2.045	.805	1/1241	5.583	86.158	8.300	41.50	21.360	24,175	58,254	
2.350	.925	1/1080	.....	.....	.....	.....	.....	.....	.....	
2.182	.859	1/1163	5.925	92.43	6.732	33.66	19.91	22,535	66,951	
2.055	.809	1/1236	4.933	77.12	5.832	29.16	18.70	21,151	72,540	
2.027	.798	1/1253	5.158	79.600	5.866	29.33	20.09	22,733	77,509	
2.2025	.867	1/1153	7.066	109.04	6.608	33.04	22.30	26,377	79,845	Washed.
2.1565	.849	1/1177	6.115	94.986	7.224	36.12	21.030	23,820	65,920	Unwashed.
1.847	.727	1/1374	6.233	95.189	7.458	37.29	29.23	33,086	88,728	
1.3755	.541	1/1847	3.308	51.050	5.232	26.16	27.995	31,700	121,100	
3.488	1.373	7/256	14.466	223.24	6.824	34.12	18.59	21,042	61,671	Do.
3.1635	1.245	8/256	11.183	172.579	6.340	31.70	17.87	20,239	63,834	Washed.
3.817	1.502	5/128	2.0791	32.095	5.890	29.45	22.83	25,840	87,748	
3.0975	1.219	8/256	15.500	239.20	7.032	35.16	25.01	28,314	80,523	Do.
3.564	1.403	7/128	18.175	208.48	7.850	39.25	22.893	25,911	66,016	Unwashed.
3.602	1.418	7/128	16.083	232.76	6.566	32.83	19.82	22,445	68,363	
2.522	.992	1/1007	16.591	256.13	6	30	41.72	47,233	157,450	
2.894	1.1392	6/128	11.450	176.700	6.400	32	21.88	24,755	76,830	
3.856	1.518	5/128	14.508	222.89	5.132	25.66	15.60	17,659	68,822	
3.201	1.260	7/128	18.108	279.44	6.100	30.50	28.26	31,985	104,850	
3.419	1.346	7/128	14.033	216.56	6.108	30.54	19.20	21,735	71,169	
3.993	1.572	5/128	24.48	377.78	5.908	29.54	24.56	27,805	94,120	
3.841	1.512	5/128	15.750	243.05	6.440	32.20	17.08	19,335	60,038	
4.151	1.634	5/128	23.10	356.48	8.082	40.41	22.52	25,490	63,080	
3.435	1.352	7/128	20.75	319.02	6.916	34.58	28.18	31,840	92,100	
3.551	1.398	7/128	24.21	373.61	8.422	42.11	30.72	34,760	84,490	
3.409	1.342	7/128	15.975	247.53	6.940	34.70	21.98	24,885	71,718	
3.430	1.350	7/128	16.03	247.38	7.050	35.25	21.80	24,670	70,000	
3.897	1.534	6/128	16.28	253.23	6.850	34.25	17.15	19,412	56,680	
3.440	1.354	7/128	18.966	293.701	7.500	37.50	25.63	29,015	77,390	
4.239	1.688	1/1000	16.69	257.66	5.924	29.62	14.86	16,820	56,780	
4.2855	1.686	5/128	21.29	328.65	13.216	66.08	18.55	20,995	31,770	
3.145	1.238	8/256	25.891	399.635	7.828	39.14	41.88	47,400	121,100	
2.751	1.083	5/128	7.616	117.532	5.474	27.37	16.10	18,223	66,583	
2.932	1.154	5/128	10.208	157.533	5.574	27.87	18.999	21,508	77,155	
3.236	1.274	7/128	13.216	203.95	6.524	32.62	20.19	22,855	70,065	
3.094	1.218	5/128	16.166	249.47	7.100	35.50	26.394	29,874	84,034	
2.469	.972	1/1028	9.758	170.59	6.450	32.25	25.611	28,987	89,883	
2.510	.988	1/1011	6.825	105.325	5.450	27.25	17.33	19,618	71,990	
3.879	1.5272	5/128	26.358	406.743	7.882	39.41	28.018	31,716	80,469	
3.5845	1.4112	7/128	20.366	314.272	11.074	55.37	25.31	28,640	51,780	
3.595	1.415	7/128	36.10	557.10	8.890	44.45	44.69	50,580	113,800	Washed
3.676	1.447	5/128	18.65	287.81	7.982	39.91	22.08	24,990	62,620	
3.435	1.352	7/128	22.04	340.12	7.390	36.95	29.88	33,823	91,540	
3.282	1.292	7/128	11.450	176.70	6.400	32	17	19,249	60,155	
3.709	1.460	5/128	22.033	340.01	8.308	41.54	18.20	20,609	49,612	
4.5935	1.8116	4/128	37.01	571.51	7.858	39.29	28.070	31,770	80,861	
3.200	1.260	7/128	32.64	503.71	8.090	40.45	51	57,722	142,700	
3.650	1.439	5/128	32.38	499.69	3.208	16.04	38.781	43,893	217,360	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
WISCONSIN—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Geo. Hardings & Son, Waukesha.	.....	39	Cotswold	Ewe	3 yrs....	170	13 0	7.62
Do	.....	40	.....do	....do ...	3 yrs....	175	11 11	6.53
Do	3835	41	.....do	....do ...	2 yrs....	180	14 6	8.71
Do	.....	42	.....do	....do ...	2 yrs....	172	.....	8.71
Do	.....	43	.....do	....do ...	2 yrs....	169	.....	10.34
Do	3836	44	.....do	....do ...	12 mos..	160	14 12	9
Do	.....	45	.....do	....do ...	12 mos..	150	12 5	9
Do	3837	46	.....do	....do ...	11 mos..	152	12 1	10.50
D. B. Jones, Werner	3842	53	Spanish Merino.	Ram....	1 yr.....	127	25 9	2
Do	.....	54	.....do	....do ...	1 yr.....	95	.....	2.05
Do	.....	54	.....do	....do ...	1 yr.....	95	16 8	2.05
Do	3844	56	.....do	Ewe	1 yr.....	97	21 2	2.05
Do	.....	56	.....do	....do ...	1 yr.....	97	22 1	.....
Do	.....	57	.....do	....do ...	.....	76	13 2	2.31
Do	3843	55	.....do	....do ...	2 yrs....	105	21 5	1.80
Do	.....	58	.....do	....do ...	1 yr.....	80	17 4	2.08
Andrew Kull, Geneva Lake.	3802	59	.....do	Ram....	6 yrs....	83	24 4	2
Do	3803	60	.....do	....do ...	3 yrs....	87	21 1	2.50
Do	3804	61	.....do	....do ...	5 yrs....	89	14 13	2.91
Do	3805	62	.....do	Ewe	2 yrs....	62	13 4	2.25
Do	3806	63	.....do	....do ...	4 yrs....	98	14 6	2
Do	.....	64	Merino	....do ...	.....	.....	.....	3.85
J. H. Pitcher, Eagle	3785	65	Spanish Merino.	Ram....	2 yrs....	143	22 12	2.82
Do	3786	66	.....do	Ewe	2 yrs....	143	18 12	1.45
Do	3787	67	.....do	....do ...	1 yr.....	115	17 7	2.57
Do	3788	68	.....do	....do ...	11 mos..	90	13 15	2.50
Do	3789	69	.....do	Ram....	1 yr.....	130	22 8	2.05
Do	3790	70	.....do	....do ...	11 mos..	100	19 1	2.24
C. K. Phelps, Springfield.	3774	71	.....do	....do ...	3 yrs....	120	25 0	3.26
Do	3775	72	.....do	....do ...	350 dys..	82	13 12	3.08
Do	3776	73	.....do	Ewe	1 yr.....	82	9 8	2.57
Do	3777	74	.....do	....do ...	350 dys..	64	10 7	2.99
Do	3778	75	.....do	....do ...	2 yrs....	86	11 1	2.72
Do	.....	76	Merino	....do ...	2 yrs....	85	.....	2.72
R. H. Mill, Palmyra.....	3815	77	Spanish Merino.	....do ...	9 yrs....	94	16 2	2.05
Do	.....	78	.....do	....do ...	9 yrs....	90	14 3	2
Do	3790	79	.....do	....do ...	5 yrs....	91	18 12	2.56
Do	.....	79	.....do	....do ...	.....	.....	.....	.....
Do	.....	80	.....do	....do ...	5 yrs....	86	15 9	2.30
Do	3818	81	.....do	....do ...	10 yrs...	84	14 7	2.05
Do	3819	82	.....do	....do ...	8 yrs....	94	10 13	2.05
J. W. Gaines, Lowell	3830	83	Hampshire ...	....do ...	4 yrs....	206	6 2	2.05
Do	.....	84	.....do	....do ...	4 yrs....	199	7 8	3.60
Englishshire and Hackney Horse Co., Neilsville.	3760	85	.....do	Ram....	3¼ yrs...	204	7 7	2.48
Do	3761	86	.....do	....do ...	1 yr.....	112	5 10	2.50
Do	3762	87	.....do	Ewe	3¼ yrs...	160	13 1	4.34
Do	.....	88	.....do	....do ...	3 yrs....	179	7 11	1.24
Do	3763	89	.....do	....do ...	1⅓ yrs..	116	8 12	3.69
Do	.....	90	.....do	....do ...	13 mos..	112	7 13	3.23
J. H. Pitcher, Eagle.....	3779	91	Pure-bred Delaine.	Ram....	2 yrs....	155	17 0	2.39
Do	3780	92	.....do	Ewe	2 yrs....	140	24 9	3.69
Do	3781	93	.....do	....do ...	1 yr.....	110	15 14	2.90
Do	3782	94	.....do	....do ...	11 mos..	96	19 4	2.80
Do	3783	95	.....do	Ram....	1 yr.....	125	27 0	4.49
Do	3784	96	.....do	....do ...	11 mos..	105	20 12	2.80
Chas. McCumber, Burlington.	3817	97	.....do	Ewe	4 yrs....	133	12 0	3.26
D. W. Cunningham, Burlington.	5759	98	.....do	Ram....	2 yrs....	110	12 13	3.26
Geo. McKerrow, Sussex..	3812	99	Oxfordshire Down.	....do ...	2 yrs....	320	15 1	5
Do	3813	100	.....do	....do ...	1 yr.....	193	13 15	5

of tests of individual samples of wool—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
4.387	1.727	1 1/8	41.32	637.64	8.668	43.34	34.351	38,879	89,707	
3.902	1.536	1 5/32	37.43	577.632	8.008	40.04	39.33	44,520	111,150	
8.409	1.342	7 1/4	26.475	408.57	7.708	38.54	36.443	41,247	134,730	
3.6135	1.4226	7 0/32	34.06	525.62	7.366	36.83	41.747	47,250	128,290	
4.329	1.704	1 1/8								
3.208	1.026	7 0/1	32.216	497.168	7.716	38.58	52.267	61,911	196,855	
3.765	1.482	3 1/4	19.61	312.62	7.632	38.16	22.13	25,060	64,164	
4.451	1.752	1 7/8	30.43	469.60	6.916	34.58	24.57	27,810	80,435	
1.9925	.784	19 1/4	10.90	169.21	5.732	28.66	43.85	49,630	173,150	
2.030	.799	19 1/31	5.983	923.317	8.366	41.83	23.23	26,295	62,851	Washed.
2.220	.874	19 1/24	5.275	81.405	7.516	37.58	17.086	19,384	51,579	Unwashed.
2.993	1.178	3 1/8	7.233	111.62	6.366	31.83	12.920	14,621	45,940	Do.
2.0305	.799	19 1/31	5.306	81.884	7.990	39.95	20.59	23,308	58,335	Washed.
2.271	.894	19 1/28	5.891	91.011	5.650	28.25	18.27	20,682	73,221	
2.330	.9176	19 9/32	7.575	116.900	7.132	35.66	22.324	25,267	70,857	
2.286	.900	19 1/20	4.450	68.673	5.224	26.12	13.62	15,423	59,160	
2.652	1.044	3 3/7	7.483	115.480	6.582	32.91	17.02	19,268	58,545	
2.256	.888	19 1/26	7.325	113.041	6.532	32.66	23.027	26,062	79,801	
2.279	.897	19 1/25	11.833	182.610	7.290	36.45	36.443	41,247	113,150	
2.276	.896	19 1/25	7.116	109.816	7.740	38.70	21.97	24,870	64,280	
2.469	.972	19 5/32	10.516	162.28	7.490	37.40	27.585	31,583	83,369	
2.081	.8196	19 1/30	7.033	108.53	7.450	37.25	20.683	23,360	62,714	
2.078	.818	19 1/31	6.400	98.767	5.708	28.54	23.714	26,840	94,043	
1.988	.7824	19 1/32	7.558	116.63	5.166	25.83	30.628	34,675	134,200	
2.434	.958	19 1/23	7.433	114.70	6.066	30.33	20.07	22,720	74,910	
2.312	.910	19 5/32	5.300	81.79	5.666	28.33	15.86	17,955	63,375	
2.170	.854	19 1/30								
2.530	.996	19 3/32	7.908	123.03	5.624	28.12	19.76	22,373	79,561	
2.140	.843	19 1/30	6.650	102.62	7.108	35.54	23.190	26,248	73,851	
2.0256	.797	19 1/24	4.900	76.618	5.674	28.37	19.119	21,639	76,274	
2.165	.852	19 1/29	6.108	94.26	6.800	34.00	20.849	23,598	69,406	
2.078	.818	19 1/31	6.366	98.24	14.882	74.41	23.642	26,697	35,878	
1.565	.616	19 1/41	6,066	93.61	5.382	26.91	39.627	44,850	167,050	
2.116	.833	19 1/30	6.400	98.76	6.424	32.12	22.87	25,884	805,811	
2.446	.963	19 3/32	6.375	98.38	6.824	34.12	17.047	19,295	56,552	
2.121	.835	19 1/30	6.666	102.87	4.882	24.41	23.708	26,833	109,620	
2.512	.989	19 1/26	6.008	92.71	7.300	36.50	15.23	17,244	47,235	Unwashed.
			5.008	77.28	6.508	32.54				Washed.
2.492	.981	19 1/26	6.108	94.26	6.682	33.41	15.809	17,811	53,311	
2.261	.890	19 1/28	6.540	100.92	7.100	35.50	20.46	23,167	65,260	
2.248	.885	19 1/28	5.575	86.08	7.308	36.54	17.65	19,978	54,671	
3.841	1.512	3 1/8	19.425	30.97	7.400	37	21.06	23,832	64,424	
3.722	1.465	3 1/8	16.608	256.30	6.724	33.62	24.132	27,316	81,258	
3.063	1.206	3 1/8	11.425	176.31	5.916	29.58	21.85	24,169	81,709	
2.779	1.094	3 1/8	11.291	174.24	4.942	24.71	23.39	26,473	107,150	
3.818	1.503	3 1/8	22.408	340.74	7.558	37.79	25.16	28,485	75,378	
3.998	1.574	3 1/8	13.800	212.96	7.092	35.46	13.49	15,635	44,090	
3.340	1.315	7 1/8	12.891	228.93	4.424	22.12	18.48	20,920	94,590	
3.7805	1.479	3 1/1	15.041	232.11	6.066	30.33	16.84	19,061	62,845	
2.586	1.018	3 1/8	7.900	122.91	6.974	34.87	18.901	20,906	61,349	
2.332	.918	19 1/28								
2.563	1.005	3 1/8	6.633	102.36	7.082	35.41	16.282	18,428	52,044	
2.332	.918	19 1/28	6.041	93.22	6.508	32.54	17.773	20,162	61,817	
2.281	.898	19 1/28	6.133	94.646	6.524	32.62	18.86	21,346	65,488	
2.337	.920	19 1/28	5.200	80.248	6.250	31.25	15.233	17,241	53,917	
2.118	.8340	19 1/30	6.275	96.837	7.790	38.95	22.381	25,331	66,550	
2.216	.8726	19 1/29	5.983	93.317	6.960	34.75	19.498	22,062	63,490	
3.528	1.3890	7 1/8	25.700	396.60	8.092	40.46	33.03	37,390	92,410	
2.670	1.051	3 1/8	24.908	375.389	6.716	33.58	55.90	63,270	188,420	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
WISCONSIN—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Geo. McKerrow, Sussex		101	Oxfordshire Down.	Ram	1 yr.	189	Not given.	5.20
Do		101	do	do	1 yr.		11 13	5.20
Do	3814	102	do	Ewe	2 yrs.	242	15 0	9.50
Do	3816	103	do	do	1 yr.	175	16 0	4.86
Do		104	do	do	1 yr.	172	14 8	4.86
Alex. White, Fulton	3791	105	do	Ram	4 yrs.	192	13 0	4.94
Do	3792	106	do	Ewe	5 yrs.	142	8 1	3.71
Do		107	do	do	5 yrs.	123	8 4	4.94
Do	3795	108	do	do	2 yrs.	150	6 14	4.13
Do	3796	109	do	do	2 yrs.	130	7 2	4.17
Do		110	do	do	2 yrs.	132	7 0	4.17
Do	3797	111	American Merino.	do		188½	12 5	2.24
Do		112	do	do		97½	10 9	2.24
Agricultural Experiment Station, Madison.	3798	113	First-cross Shropshire.	do	2 yrs.	106	12 0	3.36
Do	3799	114	do	do	3 yrs.	129½	13 0	3.36
Do		115	do	do	3 yrs.	135	9 1	2.80
Do	3800	116	do	do	2 yrs.		10 0	2.52
Do	3801	117	do	do	3 yrs.	105½	8 10	2.80
Do	3772	118	Second-cross Shropshire.	do	2 yrs.	104½	8 7	3.36
Do		119	do	do	2 yrs.	122	7 12	2.80
Do		120	do	do	2 yrs.	100	7 4	2
Do	3773	121	Dorset horn grade.	do	1 yr.	80	6 2	3.23
Do		122	do	do	1 yr.	92	6 5	4.50
Do		123	do	do	1 yr.	91	6 10	4.61
Arthur Broughton, Albany.	3756	124	Pure-bred Shropshire.	do	3 yrs.	160	10 12	2.80
Do		125	First-cross Shropshire.	do	3 yrs.	165	13 1	2.80
Do		126	Pure-bred Shropshire.	do	3 yrs.	150	13 0	2.76
Do	3757	127	Second-cross Shropshire.	do	2 yrs.	130	9 10	4.22
Do		128	do	do			41 0	1.36
Do		129	do	do	1 yr.	120	10 8	3.43
Samuel Jones, Hustiford	3839	130	First-cross Oxfordshire Merino.	do	1 yr.	70	5 13	3
Do		131	do	do	1 yr.	100	6 10	2.57
Do		132	do	do	1 yr.	80	8 7	2.50
Do		133	do	do			7 5	2.50
Do		134	do	do	1 yr.	100	9 5	2
Do	3840	135	Second-cross Oxfordshire Merino.	do	2 yrs.	90	7 9	2.50
Do	3841	136	do	do	1 yr.	90	5 1	3.75
Do		137	do	do	1 yr.	80	6 1	3
Do		138	do	do	2 yrs.	100	7 3	3
Do		139	do	do	2 yrs.	150	4 6	2.57
Alex. White, Fulton	3793	140	do	do	2 yrs.	82	7 12	4.33
Do		141	do	do	2 yrs.	70	6 9	4.94
Do	3794	142	do	do	3 yrs.		8 0	5.35
WYOMING.								
J. W. Moore	6274	1	Grade Merino.	Wether	3 yrs.		10 5	2.25
J. B. Oakie	6279	2	do	Ewe	3 yrs.		20 8	3
Do	6280	3	do	do	3 yrs.		17 4	2.12
Do	19571	4	do	do	3 yrs.			2.50
D. A. Kingsbury	6275	5	Merino	Wether	2 yrs.		9 12	1.36
Do	6276	6	Grade Merino.	do	11 mos.		7 5	2.45
Do	6277	7	do	Ewe	2 yrs.		12 0	2.45
Do	6278	8	do	Ram	8 yrs.		12 4	3.75
Jno. E. Osborne	19554	9	do	Ewe	3 yrs.		10 6	3.48
Do	19555	10	do	do	3 yrs.		8 11	
Do	19556	11	do	do	3 yrs.		8 11	1.75
Do	19557	12	do	Wether	3 yrs.		16 15	3.75

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$\frac{S}{18109} \frac{D^2}{R}$	$E = \frac{R}{P}$	Remarks.
Centimillimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
3.523	1.387	$\frac{1}{720}$	11.791	182.053	7.440	37.20	14.85	16,810	45,180	Washed.
2.678	1.054	$\frac{1}{948}$	9.191	151.938	8.024	40.12	20.504	23,207	57,846	Unwashed.
3.795	1.494	$\frac{1}{669}$	20.166	311.192	11.582	57.91	22.39	25,350	43,770	
3.9935	1.572	$\frac{1}{636}$	26.875	414.74	7.866	39.33	26.962	30,516	77,591	
4.214	1.659	$\frac{1}{603}$	22.533	347.736	6.682	33.41	20.30	22,970	68,770	
3.480	1.370	$\frac{1}{730}$	16.208	250.134	6.692	33.46	21.40	24,225	72,398	
3.2615	1.284	$\frac{1}{778}$	15.458	238.551	7.942	39.71	23.24	26,329	66,271	
4.0695	1.602	$\frac{1}{624}$	17.891	276.08	7.832	39.16	17.285	19,568	49,966	
2.888	1.1370	$\frac{1}{879}$	15.146	233.72	5.858	29.29	28.55	32,310	114,400	
3.879	1.5270	$\frac{1}{654}$	14.70	226.84	4.842	24.21	15.63	17,690	73,090	
3.5945	1.4152	$\frac{1}{706}$	27.375	422.43	8.332	41.66	33.90	38,380	92,100	
2.682	1.056	$\frac{1}{947}$	6.216	95.927	6.990	34.95	13.822	15,643	44,761	
1.900	.748	$\frac{1}{1336}$	5.075	78.319	6.082	30.41	22.441	25,399	83,523	
2.609	1.027	$\frac{1}{973}$	8.958	139.24	6.166	30.83	21.056	23,831	77,301	
2.9665	1.168	$\frac{1}{856}$	13.533	208.84	7.900	39.50	24.60	27,851	70,510	
2.5855	1.018	$\frac{1}{982}$	8.525	140.05	6.632	33.16	20.41	23,100	69,670	
2.5405	1	$\frac{1}{999}$	7.441	114.83	7.998	39.99	18.45	20,885	52,225	
2.817	1.110	$\frac{1}{901}$	9.300	143.52	5.882	29.41	18.75	21,220	72,165	
2.525	.994	$\frac{1}{1005}$	7.1583	110.47	7.466	37.33	17.96	20,531	54,460	
3.1725	1.249	$\frac{1}{800}$	11.566	178.49	6.058	30.29	18.38	20,801	68,688	
3.0685	1.208	$\frac{1}{827}$	7.908	121.04	5.858	29.29	13.44	15,215	51,943	
3.358	1.322	$\frac{1}{756}$	12.400	191.36	6.392	31.96	17.59	19,918	62,309	
2.5855	1.018	$\frac{1}{982}$	12.925	199.46	7.782	38.91	30.93	35,015	89,985	
3.4395	1.354	$\frac{1}{738}$	13.825	202.240	5.624	28.12	18.69	21,162	75,268	
2.7565	1.089	$\frac{1}{918}$	13.716	211.66	8.232	41.16	28.88	32,685	79,415	
3.0125	1.186	$\frac{1}{843}$	9.200	169.75	5.624	28.12	20.42	23,115	82,215	
2.972	1.170	$\frac{1}{854}$	8.075	135.03	5.482	27.41	14.62	16,558	60,400	
3.2155	1.266	$\frac{1}{789}$	10.575	163.196	6.416	32.08	16.36	18,520	57,725	
3.417	1.345	$\frac{1}{743}$	16.191	249.96	7.800	39.00	22.18	25,110	64,382	
2.880	1.134	$\frac{1}{881}$	12.100	186.73	6.100	30.50	23.34	26,415	86,614	
2.891	1.138	$\frac{1}{878}$	7.008	108.14	5.450	27.25	13.415	15,185	55,725	
2.5435	1.009	$\frac{1}{990}$	11.700	170.83	8.366	41.83	28.93	32,751	78,294	
2.957	1.164	$\frac{1}{859}$	9.983	165.05	7.358	36.79	18.26	20,675	56,019	
2.891	1.138	$\frac{1}{878}$	9.400	155.06	7.724	33.62	17.99	20,370	60,580	
2.688	1.050	$\frac{1}{952}$	8.950	139.11	6	30	19.81	22,435	74,772	
2.825	1.112	$\frac{1}{899}$	12.275	189.43	8.800	44	24.60	27,845	63,270	
3.8925	1.532	$\frac{1}{652}$	17.341	267.612	7.082	35.41	18.31	20,730	58,540	
2.937	1.156	$\frac{1}{865}$	10.350	159.72	5.432	27.16	19.19	21,729	80,000	
2.586	1.018	$\frac{1}{982}$	22.133	341.56	7.808	39.04	52.94	59,920	153,500	
3.884	1.529	$\frac{1}{653}$	9.858	162.14	5.808	29.04	10.45	11,835	40,750	
3.435	1.352	$\frac{1}{740}$	16.233	250.51	4.200	21	22	24,900	118,650	
2.818	1.119	$\frac{1}{893}$	16.083	248.19	8.500	42.50	32.39	36,665	86,280	
3.424	1.348	$\frac{1}{741}$	15.383	237.39	7.682	38.41	20.99	23,755	61,850	
2.215	.872	$\frac{1}{1148}$	6.400	97.22	7.766	38.83	21.352	24,167	62,238	
1.903	.749	$\frac{1}{1334}$	5.358	82.68	6.850	34.25	23.67	26,791	78,225	
2.196	.864	$\frac{1}{1157}$	5.616	86.66	5.712	28.56	21.21	24,015	84,075	
2.454	.966	$\frac{1}{1034}$	7.400	114.19	7.066	35.33	19.66	22,252	79,294	
1.768	.696	$\frac{1}{1436}$	5.233	80.75	7.550	37.75	26.78	30,317	80,310	
1.636	.644	$\frac{1}{1552}$	4.583	70.72	5.558	27.79	27.40	31,021	111,628	
2.139	.842	$\frac{1}{1187}$	4.851	74.86	6.808	34.04	16.96	19,202	56,411	
1.730	.681	$\frac{1}{1468}$	4.725	72.91	6.124	30.62	25.26	28,589	93,429	
2.180	.858	$\frac{1}{1164}$	6.558	101.205	6.190	30.95	21.57	24,989	80,740	
2.383	.938	$\frac{1}{1065}$	5.558	85.77	5.990	29.95	15.66	17,724	59,179	
1.763	.694	$\frac{1}{1440}$	3.925	61.57	6.616	33.08	20.20	22,869	69,130	
2.124	.836	$\frac{1}{1196}$	7.741	119.46	8.190	40.95	26.28	29,748	72,645	

Details of history and average results

DOMESTIC—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
WYOMING—continued.						*Pounds*	*Lbs. oz.*	*Inches.*
Jno. E. Osborne	19558	13	Grade Merino	Wether.	3 yrs		14 15	2.50
Do	19559	14	.....do	....do	3 yrs		15 0	2.50
Robert Taylor	6281	15	.....do	....do	1½ yrs		22 0	2.50
Do	6282	16	.....do	....do	1½ yrs		16 0	2.75
Do	6282a	17	.....do	....do	1½ yrs		18 4	2.75
Do	19560	18	.....do	Ram	11 mos		13 5	2.75
Do	19561	19	.....do	Ewe	11 mos		7 0	2.72
Do	19562	20	.....do	Wether.	11 mos		7 9	2.45
Do	19563	21	.....do	....do	11 mos		7 14	1.90
Do	19564	22	Shropshire Merino.	....do	2 yrs		17 13	2.75
Do		23	Merino				17 14	
Do	19566	24	.....do		2 yrs		14 2	2.25
Do	19567	25	Pure Merino	Ewe	2 yrs		10 6	3.25
Do	19568	26	.....do	....do	2 yrs		14 2	2.25
Do	19569	27	French Merino.	....do	2 yrs		14 14	2.75
Do	19572	30	Pure Merino	....do	2 yrs		9 6	2.75
Do	19573	31	.....do	....do	3 yrs		24 10	2.87

FOREIGN.

ARGENTINE REPUBLIC.								
Unknown			Merino					1.75
Juan Plance, Buenos Ayres.	27161	4	Lincoln and Merino.		1 yr		5 8	4.5
Ghiraldo, Saenz y Ca., Buenos Ayres.	27248	12	Grade Merino.	Ewe	2 yrs		7 6	2.5
Manuel Orgueira, Buenos Ayres.	27259	32	.....do	....do	2 yrs		8 10	3.7
Juan B. Bioz, Buenos Ayres.	27239	34	.....do	....do	2 yrs		7 10	2.5
Manuel F. Parea, Buenos Ayres.	27260	44	.....do	....do	2 yrs		6 7	2.50
Antonio y Pedro Lanusse, Buenos Ayres.	27252	45	Merino, cross South Dakota.	....do	1 yr		5 4	3
Rufino Baravilbara, Buenos Ayres.	27247	47	Lincoln cross.	....do	1 yr		13 7	6
Do		54		Lamb	9 mos		5 3	1.4
Devoto, Gallegos y Ca., Buenos Ayres.	27243	54	Grade Merino.					1.25
Pedro Sante, Buenos Ayres,	27267	58	.....do	Ewe	1 yr		6 0	2.25
Duggan Bros., Buenos Ayres.	27244	60	Lincoln	....do	1 yr		12 12	7
Angel T. de Alvear, Buenos Ayres.	27233	62	Grade Lincoln cross.	....do	1 yr		9 13	5
Gaston Sausinena y hijos, Buenos Ayres.	27266	64	Lincoln cross.	....do	1 yr		14 14	6.50
Juan Videla, Buenos Ayres.	27275	67	Cross Merino.	....do	2 yrs		10 12	2.50
Belisario Lynch, Buenos Ayres.	27253	68	Grade Merino.	...do	1 yr		10 6	2.50
Do		2712	Rambouillet	....do				3
Martinez F. Louza, Buenos Ayres.		2719	Merino	....do				2.25
Manuel Aguirre, Buenos Ayres.	26096		.....do	....do				1.75
Do	26906	94	Grade Merino.	....do	1½ yrs		3 3	2.5
Pedro de Achaval, Buenos Ayres.	26879	135	Rambouillet	....do	1 yr		5 1	2.5
Do	26880	133	Lincoln cross.	Lamb	6 mos		5 10	4
E. Acuna, Buenos Ayres.	26881	164	Cross Merino	Ewe			6 12	4
M. Alchurrut	26883	699	.....do	....do			10 8	3.50
Angel T. de Alvear	26885	471	Lincoln, pure.	Ram	10 mos		15 12	8.50
Do	26886	470	.....do	....do	2 yrs		15 13	9

of tests of individual samples of wools—Continued.

DOMESTIC—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2 S'} =$	$18109\frac{S}{D^2} =$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.		R.		
1.916	.754	1/1325	5.275	81.405	6.866	34.33	21.55	24,390	71,047	
1.898	.747	1/1338	4.916	76.865	6.024	30.12	21.840	24,712	82,046	
2.380	.937	1/1067	4.358	66.754	4.274	21.37	12.31	13,932	65,198	
2.043	.804	1/1243	4.633	71.492	7.250	36.25	17.76	20,101	55,450	
1.883	.741	1/1349	4.716	72.77	6.190	30.95	21.28	24,080	77,820	
2.012	.792	1/1262	5.633	86.980	6.600	33.00	22.26	25,200	76,360	
2.048	.806	1/1240	6.525	100.69	6.616	33.08	26.063	29,499	89,180	
2.144	.844	1/1184	5.691	87.92	6.490	32.45	19.808	22,420	69,090	
2.129	.838	1/1193	6.741	104.02	7.900	39.50	23.79	26,932	68,182	
2.749	1.082	8/23	11.166	172.31	6.716	33.58	34.48	39,034	116,243	
2.086	.821	1/1217	11.84	182.718	7.400	37.00	43.535	49,274	133,160	
1.979	.779	1/1283	5.408	84.45	5.832	29.16	22.09	25,005	85,755	
2.454	.966	1/1034	5.983	93.33	6.352	31.76	15.89	17,992	56,643	
2.266	.892	1/1120	5.366	83.80	5.532	27.66	16.72	18,925	58,419	
2.840	1.118	8/34	7.491	115.703	5.400	27.00	14.86	16,819	60,874	
2.520	.992	1/1007	5.641	96.189	6.732	33.66	14.212	16,087	47,790	
1.880	.743	1/1345	1.906	86.711	5.882	29.41	22.021	24,923	84,775	

FOREIGN.

1.804	.710	1/1407	4.916	76.865	6.100	30.50	24.16	27,355	89,690	
1.751	.689	1/1450	4.700	72.532	7.532	37.66	24.52	27,760	73,711	
1.669	.657	1/1521	4.850	74.846	6.232	31.16	27.85	31,530	112,580	
1.611	.634	1/1576	4.650	71.760	5.890	29.45	28.66	32,440	110,150	
2.043	.804	1/1243	5.133	79.214	5.440	27.20	19.67	22,270	81,878	
2.043	.804	1/1243	10.85	167.44	6.950	34.75	41.59	47,075	155,450	
1.999	.787	1/1276	4.408	68.025	5.658	28.29	17.65	19,975	70,610	
3.396	1.337	7/37	26.66	411.42	8.166	40.83	86.98	41,862	102,500	
1.476	.581	1/1736	4.008	61.852	5.540	27.70	29.43	33,313	120,200	
2.152	.847	1/1180	4.433	68.411	4.422	22.11	15.31	17,335	76,630	
2.574	1.013	8/25	4.925	77.003	4.732	23.66	11.89	13,463	56,892	
3.719	1.464	8/19	21.61	333.49	7.890	39.45	25.00	28,290	71,720	
3.290	1.295	7/31	25.85	398.05	9.200	46	38.21	43,245	94,018	
4.329	1.704	8/15	17.48	269.75	6.782	33.91	14.92	16,890	49,810	
1.824	.718	1/1393	6.491	100.271	9.032	45.16	31.216	35,330	78,235	
2.160	.850	1/1176	5.925	92.436	6.366	31.83	43.88	49,673	156,000	
1.753	.690	1/1448	5.041	77.794	7.590	37.95	26.297	29,706	78,277	
2.200	.866	1/1154	6.150	94.908	7.240	36.20	20.330	23,010	63,565	
1.641	.646	1/1547	.....	.....	.....	.....	.....	.....	.....	
1.789	.7043	1/1419	4.633	71.498	6.624	33.12	23.161	26,214	79,149	
2.030	.799	1/1251	7.966	109.588	6.316	31.58	30.928	35,005	110,840	
2.472	.973	1/1027	13.54	208.953	8.732	43.66	35.45	40,125	91,901	
1.931	.760	1/1315	4.200	64.815	5.158	25.79	18.02	20,390	79,090	
1.885	.742	1/1347	4.175	64.430	5.516	27.58	18.80	21,270	77,150	
4.194	1.651	6/25	34.808	537.169	8.758	43.79	31.66	35,836	81,835	
4.133	1.617	8/14	30.183	465.794	9.450	47.25	40.06	44,310	96,961	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARGENTINE REPUBLIC—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Carlos J. de Alvear	26887	846	Lincoln	Ram	3 yrs.		18 0	10
Do	26888	845	do	do	8 mos.		11 12	9.50
E. Amido	26891	810	Grade Merino	Ewe			4 4	1.5
Viuda de Apellaniz	26892	503	Rambouillet	do	2 yrs.		6 3	1.3
Do	26893	652	Grade Merino	do	2 yrs.		5 6	2
Ayarragara y Capidepont.	26895	684	do	do	2 yrs.		6 6	2.50
T. Arias	26896	53	do	do	1 yr.		3 11	2.50
Lorenzo Alcorta	26902	34	Lincoln, pure	do			8 10	7
Juan Aceval	26904	27	Cross Lincoln	do	1 yr.		5 8	4.50
Do	26905	26	Pure Lincoln	do	2 yrs.		7 5	4
Manuel S. Aguierre	26907	8	Lincoln, cross	do	1 yr.		6 14	4
Aspitarte y de los Santos	26908	538	Grade Merino	do	2 yrs.		3 2	3
Artayeta Castex de Lima	26909	280	do	do			3 4	2.5
José Ascasuso	26912	401	do	do	3 yrs.		9 0	2.50
Alfredo Alonso	26913	132	Lincoln, pure	do			10 4	7
Felix Alzaga	26914	529	Grade Merino	do	1 yr.		5 10	4
Achaval, Rodriguez y Ca.	26916	30	Lincoln cross	do	3 yrs.		6 1	4.50
Juvenal Barboza	26917	511	Grade Merino	do	2½ yrs.		1 13	3
Exequel Belando	26919	615	do	do	1 yr.		4 3	3
G. Bell	26921	674	do	do			3 10	1.50
Juan B. Bloz	26922	68	do	do	1 yr.		4 12	3.50
Do	26923	69	do	do	1 yr.		5 6	2.50
Do	26924	66	do	do	1 yr.		5 10	3.50
Do	26925	38	Lincoln, pure	do	1 yr.		7 10	6
Enrique Bonifacio, Buenos Ayres.	26926	589	Rambouillet	do	1 yr.		4 13	3.5
Do	26927	637	do	do	1 yr.		4 12	2.50
Do	26928	544	Grade Merino	do	2 yrs.		5 13	3
Do	26929	32	Lincoln, cross Merino.	do	1 yr.		6 14	4.50
Do	26930	48	Lincoln cross	do	2 yrs.		9 2	5
Enrique Bosch, Buenos Ayres.	26933	10	Lincoln, cross Merino.	do	2 yrs.		7 0	4.5
Mariano Bians, Buenos Ayres.	26937	626	Grade Merino	do	2 yrs.		5 7	2.5
Bellocq y Duranona, Buenos Ayres.	26938	621	do	do	1 yr.		5 1	3
Luis Bonjou, Buenos Ayres.	26940	60	do	do	1¼ yrs.		4 4	1
L. Ballati, Buenos Ayres.	26941	328	do	do	1 yr.		5 11	2.50
Luis P. Burgos, Buenos Ayres.	26943	473	do	do	1 yr.		5 0	2.50
Carlos Baravilbaro, Buenos Ayres.	26945	682	Rambouillet	do	2 yrs.		6 1	3
Oswaldo S. Carrizo, Buenos Ayres.	26946	577	Lincoln cross	do				3.75
P. Carricaburo, Buenos Ayres.	26947	597	Merino	do	1 yr.		4 9	2
Juan Chapar, Buenos Ayres.	26918	515	Grade Merino	do	2 yrs.		5 4	3
Do	26949	313	Lincoln cross	do	2 yrs.		7 12	2.50
M. Chiezza, Buenos Ayres.	26950	638	do	do	1 yr.		6 8	5
Chillado, Gonzales y Ca., Buenos Ayres.	26951	289	Rambouillet	do	2 yrs.		6 12	3
Do	26952	635	Grade Merino	do	1 yr.		4 8	2.55
Do	26953	459	Lincoln cross	do	1 yr.		7 2	5
Martin Colmann, Buenos Ayres.	26957	323	Grade Merino	do	2 yrs.		6 8	4
Rafael Cirto, Buenos Ayres.	26959	643	do	do	2 yrs.		6 14	2
Cernadas y Inbarne, Buenos Ayres.	26960	73	do	do			5 6	2.50
Ceasar Cardosa, Buenos Ayres.	26961	630	Rambouillet	do	3 yrs.		20 8	3.20
Doctor Carrié, Buenos Ayres.	36962	11	Lincoln, cross Merino.	do	1 yr.		5 8	5
Correa y Larrazabel, Buenos Ayres.	26963	122	Grade Merino	do	2 yrs.		4 6	2.50

of tests of individual samples of wool—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109\frac{S}{D^2} =$	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
3.061	1.205	1/25	19.433	309.89	7.208	36.04	33.185	37,561	104,216	
2.9085	1.367	1/21	25.233	389.40	3.674	18.37	47.72	60,710	33,048	
2.119	.834	1/120	4.625	71.374	6.216	31.08	16.48	18,650	60,015	
2.011	.791	1/126	5.025	77.447	6.408	32.04	19.880	22,501	70,228	
2.119	.834	1/120	5.016	77.412	5.800	29	17.873	20,229	69,757	
2.114	.832	1/201	5.658	87.316	7.690	38.45	20.256	22,927	59,628	
1.819	.716	1/300	5.316	82.038	7.024	35.12	25.70	29,090	82,840	
3.866	1.522	1/66	30.083	464.25	9.132	45.66	41.661	47,153	103,270	
2.283	.879	1/137	11.95	185.416	7.882	39.41	38.34	43,400	110,100	
2.977	1.172	1/83	9.833	161.746	6.874	34.37	17.752	20,091	58,457	
2.363	.930	1/107	5.391	83.296	7.682	38.41	15.44	17,480	45,516	
1.989	.783	1/128	5.741	88.597	7.140	35.70	23.218	26,279	73,611	
1.913	.753	1/133	4.666	71.997	6.540	32.70	20.40	23,088	70,610	
2.373	.934	1/107	5.458	84.229	5.382	26.91	15.507	17,552	65,225	
3.650	1.437	1/69	13.75	212.185	8.066	40.33	16.551	18,690	73,786	
2.223	.875	1/114	5.725	88.350	7.308	36.54	18.536	20,979	57,414	
2.604	1.025	1/98	6.766	104.41	6.500	32.50	15.964	18,069	55,598	
2.193	.863	1/116	5.066	78.180	6.308	31.54	16.854	19,075	60,481	
2.040	.803	1/124	4.600	71.088	6.816	34.08	17.685	20,016	58,734	
1.837	.723	1/138	4.766	73.55	7.732	38.66	22.59	25,570	66,155	
2.281	.898	1/113	4.566	70.37	7.082	30.41	14.041	15,855	52,259	
1.939	.763	1/130	5.055	77.933	7.100	35.50	21.49	24,325	68,518	
2.353	.926	1/107	5.276	81.266	7.650	38.25	15.21	17,220	45,080	
3.574	1.407	7/16	20.67	318.986	8.608	43.04	25.89	29,305	68,082	
2.269	.893	1/111	4.691	72.493	6.708	33.54	14.57	16,500	49,190	
2.309	.909	1/109	4.191	64.776	5.632	28.16	12.57	14,235	50,550	
2.198	.865	1/115	4.416	68.149	5.832	29.16	14.62	16,555	56,760	
1.845	.726	1/137	13.03	201.083	7.090	35.45	61.245	69,318	195,580	
2.622	1.032	9/25	17.54	270.68	7.008	35.04	40.82	46,200	131,850	
2.883	1.135	9/25	19.87	316.64	7.750	38.75	38.24	430,290	111,750	
2.279	.897	1/114	5.850	90.279	6.516	32.58	18.062	20,396	62,605	
2.248	.885	1/113	5.066	78.180	6.216	31.08	16.002	18,153	58,409	
1.857	.731	1/137	6.466	98.735	8.082	40.41	30.00	33,955	84,026	
2.203	.867	1/118	5.816	89.750	7.800	39	19.17	21,700	55,640	
2.083	.820	1/124	4.616	71.235	3.708	28.54	17.021	19,265	67,503	
1.692	.666	1/150	4.158	64.167	5.450	27.25	23.237	26,304	96,518	
2.937	1.156	6/64	12.81	197.68	6.650	33.25	23.77	26,892	80,880	
2.033	.800	1/125	4.941	83.25	6.690	33.45	19.128	21,648	64,720	
2.015	.793	1/126	4.483	69.183	6.166	30.83	17.661	19,994	64,854	
2.375	.9348	1/107	5.991	83.55	7.116	35.58	16.903	19,233	54,058	
3.470	1.366	7/21	21.65	334.110	8.050	40.25	28.768	32,560	80,896	
2.302	.906	1/110	4.950	77.390	6.308	31.54	14.94	16,912	53,630	
2.464	.970	1/103	5.633	89.930	6.966	34.83	14.84	16,802	48,235	
3.404	1.340	7/16	14.51	233.92	6.666	33.33	20.03	22,670	68,035	
1.728	.680	1/146	3.783	58.380	7.482	37.41	20.270	22,942	61,327	
2.027	.798	1/125	4.333	66.868	5.440	27.20	16.87	19,090	70,215	
2.414	.950	1/105	5.800	78.352	6.616	33.08	15.56	17,610	53,240	
2.203	.867	1/118	5.166	79.724	6.900	34.50	17.03	19,275	55,875	
3.318	1.306	7/85	13.72	211.73	7.658	38.29	19.94	22,565	58,940	
2.083	.820	1/119	4.400	67.902	5.190	25.95	16.225	18,364	70,767	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARGENTINE REPUBLIC—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Juan Cañás, Buenos Ayres.	26964	427	Lincoln cross.	Ewe	1 yr.		7 11	6
Federico Cibils, Buenos Ayres.	26965	468	Lincoln, pure.	do	2 yrs.		11 0	8
Tomas Deloy, Buenos Ayres.	26969	601	Bambouillet.	do	2 yrs.		6 14	2.50
Do	26970	548	Lincoln cross.	do	2 yrs.		8 0	5
Nicolas Delaner, Buenos Ayres.	26971	370	Grade Merino.	do			3 8	2.50
Devoto, Galegoso y Ca., Buenos Ayres.	26973	179	do	do	1 yr.		11 14	3
Devoto, Balbiani y Ca., Buenos Ayres.	26972	333	Grade Rambouillet.	do	3 yrs.		5 13	2.50
Ramon Diaz, Buenos Ayres.	26976	157	Grade Merino.	do	1 yr.			2.50
Duggan Bros., Buenos Ayres.	26978	305	Lincoln cross.	do	2 yrs.		8 8	6.50
Do	26979	293	Lincoln, pure.	do	1 yr.		8 14	7
Adolfo Duguenay, Buenos Ayres.	26980	677	Merino	do			6 3	2.70
Manuel Duranona, Buenos Ayres.	26981	604	Rambouillet.	do	2 yrs.		8 7	2.50
Simon Ezcurra, Buenos Ayres.	26982	486	Lincoln cross.	do	1 yr.		4 3	4.50
M. Duranona, Buenos Ayres.	26983	616	do	do	1 yr.		6 6	5
Dierks & Messtorff, Buenos Ayres.	26984	614	Grade Rambouillet.	do	2 yrs.		6 0	3
Errea y Urtasein, Buenos Ayres.	26990	647	Lincoln cross.	do	1 yr.		7 10	5
Simon Ezcurra, Buenos Ayres.	26992	667	Grade Merino.	do	2 yrs.		8 12	2.50
Etcheto y Etchart, Buenos Ayres.	26993	118	do	do	2 yrs.		3 10	1.50
Bautista Echeverry, Buenos Ayres.	26994	639	do	do	1½ yrs.		5 9	2.50
Do	26995	28	Grade Lincoln	do	1 yr.		6 0	4.50
Juan Elizalde, Buenos Ayres.	26996	157	Bambouillet.	do	1 yr.		5 1	3
Nicanor Ezeiza, Buenos Ayres.	26997	106	Grade Merino.	do	2 yrs.		6 8	2.50
Juan José Ezeiza, Buenos Ayres,	26998		Rambouillet.	do	2 yrs.		6 3	3
Agusta de Elia, Buenos Ayres.	26999	42	Lincoln cross.	do	1 yr.		10 14	5
Fermin Echarry, Buenos Ayres.	27000	558	Grade Merino.	do	1 yr.		5 5	2.25
Tomas Maguirre, Buenos Ayres.	27001	215	do	do	1 yr.		5 13	3
Carlos Tremery, Buenos Ayres.	27004	533	Rambouillet.	do	2 yrs.		7 5	2.50
Do	27005	410	Grade Rambouillet.	do	1 yr.		5 8	3.50
Do	27006	420	Grade Merino.	do	2 yrs.		8 0	2.50
Do	27007	366	Cross bred	Lamb	2 yrs.		7 11	2.50
Celestine Garros, Buenos Ayres.	27013	496	Lincoln, pure.	Ewe	1 yr.		10 8	9.50
Do	27014	689	Lincoln cross.	do	1 yr.		12 9	7
Gibson Bros., Buenos Ayres.	27015	864	Lincoln	do	1 yr.		8 14	8
Do	27016	865	do	do	1 yr.		8 12	7.50
Do	27017	866	Lincoln cross.	do	1 yr.		7 3	8.50
Do	27018	867	do	do	1 yr.		8 3	8.50
Ghinotis y Pedesta	27020	421	Grade Merino.	do	2 yrs.		7 4	3
Ghiraldo, Saenz y Ca	27021	200	do	do	2 yrs.		5 15	3
Miguel Gogorza	26022	585	Lincoln cross.	do	2 yrs.		7 0	6.50
Ignacio Goni	27023	332	do	do	1 yr.		8 9	5
Graciarena Hnos	27026	120	Grade Merino.	do	2 yrs.		6 0	3
Juan C. Giribone	27030	43	Lincoln cross.	do	2 yrs.		4 8	3.50
Alejandro Gallardo	27031	116	Grade Merino.	do	2 yrs.		6 12	2.50
Octavio T. Gonzales	27032	117	do	do	1 yr.		5 5	2.50

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2 R} =$	$E = \frac{R}{P}$	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
2.904	1.143	1/22	12.46	191.71	5.840	29.20	23.639	26,755	91,629	
3.460	1.362	3/44	26.80	413.58	7.540	27.70	35.81	40,536	107,500	
2.172	.855	1/116	5.150	79.47	7.200	36	17.506	19,814	55,040	
2.838	1.117	5/44	12.16	187.65	5.358	26.79	24.156	27,340	10,205	
2.299	.905	1/104	6.400	98.76	7.516	37.58	19.37	21,925	58,349	
1.954	.769	1/130	4.925	77	7.640	38.20	20.638	23,358	61,148	
1.766	.696	1/143	5.883	90.78	8.124	40.62	30.18	34,158	84,092	
2.081	.819	1/122	4.941	77.251	6.482	32.41	18.255	20,661	63,750	
3.536	1.392	7/88	21.43	330.71	7.266	36.33	37.423	31,038	85,433	
2.982	1.174	27/88	27.675	427.09	8.000	40	49.795	58,186	14,566	
2.634	1.037	6/84	6.191	95.641	7.608	38.04	14.96	16,920	44,481	
1.870	.736	1/132	4.975	77.775	6.666	33.33	22.762	25,704	77,297	
2.812	1.070	15/88	15.22	234.88	6.868	34.37	30.796	34,856	101,410	
3.015	1.187	21/88	10.233	15.791	6.908	39.54	18.011	20,385	51,556	
2.322	.914	1/108	6.100	94.137	6.208	31.04	18.101	20,487	66,005	
2.020	.795	1/126	5.758	88.859	7.900	39.50	22.578	25,554	64,694	
2.063	.820	1/112	4.391	67.863	6.382	31.91	16.19	18,320	57,430	
1.758	.692	1/144	4.658	71.883	7.082	35.41	24.11	27,290	77,070	
2.119	.834	1/120	4.741	73.164	6.940	34.70	16.890	19,120	55,100	
2.5325	.997	1/100	6.915	107.714	5.900	29.50	17.250	19,524	66,185	
3.907	1.538	43/88	21.75	335.65	9.190	45.95	22.79	25,800	56,150	
2.299	.905	1/104	7	108.02	8.124	40.62	21.19	23,980	59,040	
1.867	.735	1/136	5.491	84.90	7.966	39.83	25.204	28,461	71,622	
3.6755	1.447	45/88	12.391	191.32	7.374	36.87	14.675	166,090	567,140	
2.050	.807	1/124	4.991	78.120	6.732	33.66	19.002	21,506	63,894	
2.297	.904	1/108	5.566	85.906	6.766	33.83	16.917	19,103	56,468	
1.860	.732	1/136	5.050	77.933	7.190	35.95	23.350	26,433	73,529	
2.106	.829	1/120	5.441	83.967	7.808	39.04	19.628	22,200	56,327	
2.185	1.009	1/100	5.851	90.403	8.016	40.08	19.632	22,229	55,438	
2.563	1.000	9/88	9.825	181.623	6.324	31.62	28.93	27,084	85,658	
3.668	1.440	41/88	32.55	502.32	4.666	23.33	38.709	43,710	137,780	
2.594	1.021	11/88	10.90	169.21	7.758	38.79	25.918	29,327	75,606	
3.183	1.253	27/88	18.475	285.112	9.700	48.50	29.180	33,025	68,090	
2.512	.989	1/101	16.491	245.59	6.600	33	41.821	47,334	143,437	
3.536	1.392	7/88	18.05	278.55	4.700	23.50	23.097	26,142	111,240	
2.291	.902	1/108	11.29	174.33	4.416	22.08	33.632	38,065	172,400	
2.027	.798	1/126	5.283	81.529	8.050	40.25	20.57	23,280	57,850	
2.703	1.064	5/88	5.016	77.408	6.632	33.16	10.98	12,430	37,490	
2.8515	1.225	31/88	18.95	293.44	7.882	39.41	37.30	42,220	107,100	
2.690	1.059	13/88	20.31	313.43	7.982	39.91	44.90	52,010	127,300	
2.124	.836	1/120	4.716	72.77	5.832	29.16	16.72	18,930	64,908	
2.1735	.857	1/116	9.841	161.86	6.250	31.25	33.34	37,740	120,750	
2.266	.892	1/112	4.783	73.812	6.982	34.91	14.903	16,867	48,319	
2.088	.822	9/88	4.891	75.579	7.000	35.00	17.949	20,315	58,044	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARGENTINE REPUBLIC—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Ramon Gonzales	27035	5	Lincoln cross.	Ewe	2 yrs		5 10	3.50
Martin Graciarena	27036	124	Grade Merino.	do	1 yr		5 11	2.50
Jose Garcia	27037	655	Rambouillet.	do	2 yrs		6 5	3
G. B. Hallett & Co	27041	672	Grade Merino.	do	1 yr		4 0	3
Patricio Ham	27043	430	do	do	3 yrs		9 5	3
Do	27044	458	do	do	2 yrs		9 2	3
Maximo Hopff	27045	136	Merino	do	1 yr		2 4	2.5
Do	27046	745	Grade Merino.	do	1 yr		4 0	2
Imas y Rivero	27049	657	Grade Rambouillet.	do	1 yr		4 11	2.50
Juan Inchampe	27051	52	Merino cross.	do	1 yr		4 2	3.50
Amadeo Jolly	27053	549	Grade Merino.	do	2 yrs		4 4	3
Dr. Enrique Keen	27054	854	Rambouillet.	do	2 yrs		8 1	3.50
Carlos Fremery	27008	434	Lincoln cross.	do	1 yr		4 4	5
Sonano Garcia	27011	608	Rambouillet.	do	2 yrs			2
Dr. Enrique Keen	27055	855	Rambouillet and Southdown.	do	1 yr		9 2	4.50
José Seguneche é hijo	27056	618	Merino	do	1 yr		5 9	2
Pedro y Antonio, Lanusse.	27057	543	Grade Merino.	do	1 yr		4 11	2.50
Do	27058	661	do		1 yr		5 3	3
Do	27059	623	Lincoln cross.	do	1 yr		7 4	6
S. Larrambe	27060	522	Grade Merino.	do	2 yrs		8 0	3
Salvador Larredi	27061	680	do	do	2 yrs		5 3	2
Federico Leloir	27064	190	Lincoln and Rambouillet.	do			7 6	3
Nicholas Lowe	27066	852	Rambouillet.	do	2 yrs		8 3	3
Salvador Sarrede	27066		Merino	do				2.75
Nicholas Lowe	27067	853	Lincoln	do	1 yr		9 10	9
Cicilio Lopez	27068	462	Lincoln, pure.	Ram	1 yr		9 4	9.50
Ferrando Laronde	27069	7	Lincoln, first and second cross.	Ewe	2 yrs		5 2	3
Belisario Lynch	27070	130	Grade Merino.	do	2 yrs		8 13	2
Manuel S. Lopez.	27071	12	Lincoln, one-half cross.	do	2 yrs		7 11	5.50
José Ma. Loughlin	27072	107	Grade Merino.	do			3 14	2.50
Patricio Maguirrre	27075	441	Grade Rambouillet.	do	2 yrs		4 10	3
Felipe Martinez	27076	542	Lincoln, cross Merino.	do	2 yrs		6 10	4
T. Martens	27077	512	do	do	2 yrs		7 0	4
T. M. Mendez y Ca., Buenos Ayres.	27079	536	Grade Merino.	do	1 yr		5 5	2.50
José Moras é hijos. Buenos Ayres.	27083	857	Rambouillet.	do	2 yrs		6 9	2.50
Do	27084	858	do	Buck			21 8	3.50
Do	27085	859	do	Ewe	3 yrs		10 12	3
Do	27086	867	Negretti	Ram	2 yrs		14 1	2.50
Do	27087	862	do	Ewe	2 yrs		11 2	2.50
Do	27088	860	Lincoln	Ram	2 yrs		9 13	7.5
Do	27089	863	do	Ewe			10 14	9.50
Juan Murray, Buenos Ayres.	27090	29	Lincoln, cross Merino.	do	2 yrs		5 12	5
Do	27091	645	Lincoln, cross.	do	2 yrs		7 2	4.50
Antonio Monasterio, Buenos Ayres.	27092	474	Grade Merino.	do			5 13	2.5
P. Marcenave, Buenos Ayres.	27093	119	do	do	2 yrs		5 4	3
Miguel Martinez de Hoz, Buenos Ayres.	27094	65	do	do	2 yrs		7 6	2
Emilio Martinez de Hoz, Buenos Ayres.	27095	199	Grade Rambouillet.	do	1 yr		4 15	3
Do	27096	550	Lincoln, cross Merino.	do	2 yrs		6 4	3.50
Lorenzo Moreno, Buenos Ayres.	27098	806	Merino	do			5 6	2.70
Antonio Miguens, Buenos Ayres.	27100	668	Grade Merino.	do	2½ yrs		6 8	2.50

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
2.894	1.139	9/77	14.41	222.38	6.858	34.29	27.528	31,157	90,864	
2.215	.872	1/116	6	92.594	7.958	39.29	19.566	22,146	56,365	
2.408	.948	1/104	6.316	97.470	6.298	31.04	17.428	19,735	63,548	
1.989	.783	13/76	5.191	80.209	6.982	34.91	20.99	23,762	68,065	
2.332	.918	1/109	5.833	80.016	7.250	36.25	17.16	19,435	53,584	
2.331	.878	1/113	4.700	72.532	6.224	31.12	13.84	15,663	50,330	
1.839	.724	13/80	5.383	84.615	7.116	35.58	26.00	28,755	80,825	
1.951	.768	1/130	4.391	67.863	5.082	25.41	18.45	20,890	82,215	
1.982	.780	13/81	5.716	88.211	3.950	29.75	23.28	26,348	88,570	
1.880	.740	1/135	8.475	130.78	8.016	40.08	38.36	43,420	100,800	
1.951	.768	13/83	4.883	75.366	6.524	32.62	20.52	23,235	71,215	
2.626	1.034	9/87	6.616	10.210	6.640	33.20	15.350	17,334	52,331	
2.609	1.027	9/73	4.350	67.130	7.666	38.33	10.22	11,571	30,192	
2.264	.891	11/91	5.616	86.680	6.816	34.08	17.692	19,841	58,219	
1.829	.720	1/138	5.225	80.634	7.166	35.83	24.99	28,284	78,941	
2.561	1.008	9/81	5.641	87.053	6.400	32	13.761	15,574	48,672	
2.256	.888	11/93	4.958	77.513	6.816	34.08	15.586	17,641	51,763	
2.541	1	1/96	6.666	102.87	6.566	32.83	16.518	18,695	56,948	
3.229	1.271	7/78	17.73	275.66	8.100	40.50	27.207	30,794	76,034	
2.388	.940	1/103	5.850	90.279	7.140	35.70	16.413	23,382	65,510	
2.195	.864	11/87	4.825	74.46	6.458	32.29	16.06	18,135	56,163	
2.088	.822	13/78	5.916	92.297	6.832	34.16	21.711	24,573	71,935	
2.271	.894	1/112								
2.0575	.810	13/84	5.633	86.928	7	35	21.290	24,096	68,847	
3.279	1.291	7/74	22.475	347.84	8.966	44.83	33.453	37,862	64,456	
4.049	1.594	5/77	28.66	442.29	7.842	39.21	27.970	31,657	80,737	Washed.
3.529	1.389	7/75	13.25	204.46	5.340	26.70	17.022	19,266	72,159	
2.208	.869	1/116	4.225	65.201	5.266	26.33	13.952	15,791	59,975	
3.521	1.386	7/81	18.06	278.70	8.466	42.33	23.30	26,380	62,320	
1.972	.776	13/67	5.083	78.442	5.800	29	20.91	23,670	81,620	
2.180	.858	11/84	4.916	76.865	6.216	31.08	16.55	18,730	60,273	
3.381	1.331	7/81	12.766	197.009	7.200	36	60.412	68,359	189,887	
2.792	1.099	5/89	9.550	157.37	6.742	33.71	18.59	22,185	65,810	
2.195	.864	11/87	5.300	81.791	5.266	26.33	17.60	19,920	75,657	
2.271	.894	1/118	5.641	87.053	5.458	27.29	17.50	19,807	72,579	
2.551	1.004	9/85	9.558	157.391	6.574	32.87	23.50	26,592	80,920	
2.228	.877	11/89	5.091	78.666	4.690	23.45	16.409	18,572	79,200	
2.594	1.021	9/75	5.241	80.880	6.758	33.79	12.462	14,104	41,742	
2.261	.890	1/113	6.133	94.64	6.182	30.91	19.195	21,720	70,285	
3.259	1.283	7/79	30.88	476.56	8.150	40.75	46.51	52,650	129,200	
3.681	1.449	6/85	21.08	325.30	9.000	45	24.89	28,105	62,460	
2.906	1.144	9/73	13.32	205.55	7.516	37.58	25.17	28,493	75,830	
2.876	1.132	9/75	11.24	173.45	5.066	25.33	21.74	24,601	97,150	
2.297	.904	11/103	5.766	88.062	6.982	34.91	17.48	19,790	56,680	
2.137	.841	11/128	4.266	64.741	6.266	31.33	15.338	17,310	55,251	
2.368	.932	1/107	4.841	74.708	5.274	26.37	13.813	15,633	59,286	
2.058	.810	1/124	4.791	74.036	6.290	31.45	18.098	20,484	66,651	
3.445	1.356	7/57	13.816	213.89	6.800	34	18.618	21,072	61,977	
2.266	.892	1/120	5.266	81.166	6.332	31.66	16.40	18,570	58,760	
2.246	.884	1/130	5.191	80.209	6.316	31.58	16.464	18,634	60,243	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARGENTINE REPUBLIC—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Tomas Maguirre, Buenos Ayres.	27101	320	Rambouillet..	Ewe	1 yr.....	.....	5 12	2.50
Agustin Miguelarena, San Agustin.	27102	850	.....do	....do ...	½ yr....	.....	3 6	2.25
Do.....	27103	851	.....do	....do ...	½ yr....	.....	2 1	2.1
Felip Martinez de Hoz, San Agustin.	27105	807	Grade Merino.	....do ...	.....	.....	4 7	2
Mendiburo y Ishtilart, Entre Rios.	27107	856	Rambouillet and Lincoln cross.	....do ...	1 yr.....	.....	5 4	2
Necol y Aguirre, Entre Rios.	27108	.....	Merino	....do ...	.....	.....	.....	2
Ricardo Newton, Entre Rios.	27109	843	Lincoln, pure.	Lamb...	1 yr.....	.....	7 10	7.5
Liborio Novara, Entre Rios.	27110	549	Merino	Ewe	2 yrs....	.....	5 0	3
Señor Nuñez, Entre Rios.	27112	180	Grade Merino.	....do ...	.....	.....	6 3	2.5
Benjamin Nazar, Entre Rios.	27114	714	.....do	Buck ...	4 yrs....	.....	27 13	2.50
Do.....	27115	726	.....do	....do ...	1 yr.....	.....	16 6	2.50
Do.....	27116	719	.....do	Ewe	1 yr.....	.....	16 12	3
J. M. Ortega, Entre Rios.	27119	228	.....do	....do ...	.....	.....	4 14	2
Fermin Ortiz, Entre Rios.	27120	636	Rambouillet..	....do ...	2 yrs....	.....	7 4	3.5
Do.....	27121	1	Lincoln cross.	....do ...	2 yrs....	.....	5 3	3.50
Julian Ortiz, Entre Rios.	27122	185	Grade Merino.	....do ...	2 yrs....	.....	6 13	2
Busualdo Ortiz, Entre Rios.	27127	598	Merino cross..	....do ...	1 yr.....	.....	4 1	3
Juan Ochat, Entre Rios..	27128	35	Lincoln cross.	....do ...	1 yr.....	.....	9 13	5
Juan R. de Olasco, Entre Rios.	27129	41	.....do	....do ...	1 yr.....	.....	4 12	4.50
Manuel F. Parea, Entre Rios.	27130	488	Grade Merino.	....do ...	3 yrs....	.....	7 2	3
Do.....	27131	602	Grade Rambouillet.	....do ...	1 yr.....	.....	5 0	3
Pegassano Hnos. y Repetto, Entre Rios.	27133	675	Grade Merino.	....do ...	3 yrs....	.....	5 14	3
Pegassano Hnos. y Repetto, Buenos Ayres.	27134	527	.....do	....do ...	2 yrs....	.....	5 6	2
Tolls Peralta, Buenos Ayres.	27136	506	.....do	....do ...	2 yrs....	.....	8 8	2.50
Perez y Cueto, Buenos Ayres.	27138	534	Grade Rambouillet.	....do ...	3 yrs....	.....	5 7	2.50
Juan Petersen, Buenos Ayres.	27140	274	Grade Merino.	....do ...	2 yrs....	.....	6 8	3.5
Planas Hnos., Buenos Ayres.	27142	112	.....do	....do ...	1 yr.....	.....	4 2	2.50
Antonio Pereyra, Buenos Ayres.	27145	24	Lincoln cross.	....do ...	1 yr.....	.....	5 7	5
Pena Hnos., Buenos Ayres.	27146	17	.....do	....do ...	1 yr.....	.....	5 14	5.50
Manuel R. Patino, Buenos Ayres.	27147	19	.....do	....do ...	2 yrs....	.....	3 10	4.50
Demetrio Pereyra, Buenos Ayres.	27148	880	Grade Merino.	....do ...	.....	.....	3 14	2
Palma y Brandi, Buenos Ayres.	27149	92	.....do	....do ...	.....	.....	3 7	2.50
Marcus Pera, Buenos Ayres.	27150	82	.....do	....do ...	.....	.....	4 0	2
Juan Plance, Buenos Ayres.	27151	4	Lincoln, cross Merino.	....do ...	1 yr.....	.....	5 8	4.50
A. y E. Pierres, Buenos Ayres.	27152	3	.....do	....do ...	2 yrs....	.....	6 8	6
Do.....	27153	2	.....do	....do ...	1 yr.....	.....	8 1	7
Pourtalet Hnos., Buenos Ayres.	27157	284	Grade Merino.	....do ...	.....	.....	5 4	2.5
Diego Ramsay, Buenos Ayres.	27159	8	.....do	....do ...	2 yrs....	.....	6 15	3.50
Do.....	27160	306	Grade Rambouillet.	....do ...	2 yrs....	.....	6 8	2.50
José Rodriguez, Buenos Ayres.	27166	679	... .do	....do ...	2 yrs....	.....	6 9	2.50

of tests of individual samples of wool—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2} =$	$E = \frac{R}{l'} \cdot$	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.		R.		
2.081	.819	1/1220	5.583	86.158	7.066	35.33	20.62	23,340	66,080	
1.867	.735	1/1360	4.466	68.920	5.366	26.83	20.499	23,201	86,477	
2.434	.958	1/1043	5.250	81.019	5.550	27.75	14.17	16,043	57,827	
2.276	.896	1/1115	4.241	64.44	5.658	28.29	13.09	14,820	52,402	
1.837	.723	1/1383	5.025	77.542	7.416	37.08	27.338	30,938	83,437	
2.370	.933	1/1071	4.666	72.007	5.082	25.41	13.290	15,040	59,200	
4.522	1.780	1/561	27.89	430.50	7.930	39.65	21.820	24,690	62,290	
2.106	.829	1/1205	5.283	91.529	6.716	33.58	19.058	21,570	64,235	
2.350	.925	1/1080	6.508	100.43	3.774	18.87	18.85	21,340	113,000	
2.137	.841	1/1188	4.775	73.609	6.058	30.29	16.72	18,930	62,511	
2.022	.796	1/1256	6.916	107.730	7.774	38.87	27.06	30,630	78,700	
2.253	.887	1/1127	4.383	67.640	6.124	30.62	13.815	15,636	51,066	
2.634	1.037	1/964	5.290	80.737	4.750	23.75	12.19	13,800	58,135	
1.710	.673	1/1486	4.441	68.535	6.416	32.08	24.30	27,500	85,730	
2.264	.891	1/1121	8.050	12.423	7.558	37.79	25.128	28,440	75,259	
2.055	.809	1/1235	3.925	61.571	5.358	26.79	14.870	16,831	62,825	
2.690	1.059	1/944	8.008	12.357	5.324	26.62	17.706	20,040	75,284	
2.809	1.059	1/944	12.80	197.53	3.882	19.41	25.955	29,376	151,340	
2.919	1.149	1/870	14.35	221.45	6.666	33.33	26.94	30,490	91,500	
2.330	.917	1/1090	5.833	90.016	7.274	36.37	17.19	19,450	53,490	
2.375	.935	1/1069	5.608	86.54	7.408	37.04	15.90	18,000	48,600	
1.860	.732	1/1364	4.208	64.93	5.708	28.54	19.46	22,020	77,175	
1.918	.755	1/1324	4.458	68.79	6.024	30.12	19.38	21,943	72,859	
2.182	.859	1/1163	5.825	89.89	5.216	26.08	19.575	22,155	84,951	
1.849	.728	1/1373	4.758	73.42	6.290	31.45	22.267	61,911	196,855	
1.870	.736	1/1358	4.358	67.25	4.516	22.58	19.94	22,565	99,945	
1.748	.688	1/1452	3.958	62.08	5.308	26.54	20.72	23,450	88,380	
3.310	1.303	1/767	2.226	34.351	7.640	38.20	32.507	36,776	96,316	
2.680	1.055	1/947	11.758	181.45	8.946	44.73	26.198	29,645	66,276	
2.657	1.046	1/956	7.033	108.53	5.266	26.33	19.938	18,040	68,517	
1.832	.721	1/1386	4.933	77.12	5.184	25.92	23.571	26,616	102,680	
2.187	.861	1/1161	5.883	90.68	4.950	24.75	19.68	22,270	90,000	
1.817	.715	1/1397	4.758	73.42	5.716	28.58	23.05	26,092	91,310	
2.711	1.067	1/937	9.725	159.97	6.708	33.54	21.17	23,960	71,440	
3.6145	1.423	1/703	18	177.782	8.500	42.50	22.044	24,950	58,705	
3.269	1.287	1/778	15	231.48	6.858	34.29	22.45	25,410	74,120	
2.096	.825	1/1211	4.033	62.238	4.032	20.16	15.07	16,980	85,045	
2.187	.861	1/1161	5.675	87.578	5.416	27.08	18.98	21,485	79,345	
2.162	.851	1/1174	4.783	73.812	5.932	29.66	16.372	18,530	62,470	
2.235	.955	1/1048	4.375	67.516	6.040	30.20	14.013	15,860	52,518	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ARGENTINE REPUBLIC—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Juan Videla, Buenos Ayres.	27223	844	Lincoln, pure.	Ewe	1 yr		9 10	7.50
Pedro Whalan, Buenos Ayres.	27228	841	Lincoln cross.	do	2 yrs		5 13	6.50
Luis Ma. Saavedra, Buenos Ayres.	27229	691	Merino	do			11 0	4
Antonio Ojea, Buenos Ayres.	27117	442	Grade Merino.	do	2 yrs		5 14	3
José Rodriguez, Buenos Ayres.	27168	648	Lincoln cross.	do	2 yrs		6 5	4.50
Octavio Gonzales, Buenos Ayres.	27033	34	do	do			5 10	6
Juan P. Althapairo, Buenos Ayres.	26903	39	do	do	1 yr		4 10	5.50
W. H. Hallet, Buenos Ayres.	27042	281	Grade Rambouillet.	do	1 yr		4 15	3
Enrique Bonifacio, Buenos Ayres.	26926	577	Cross Lincoln.	do	1 yr		5 4	4.50
Do				do	1 yr		4 4	5
Do				do	2 yrs		7 11	2.50
Chamber of Commerce	27201	874						
CANADA.								
Unknown		A	Cotswold					9
Do		B	Shearling Shropshire.					5.25
J. B. Lander		C	do	Wether				5.50
William Dickson		D	Grade Shropshire.	do				4.50
J. B. Sauer		E	Shearling Shropshire.	do				4.50
William Dickson		F	do					
ECUADOR.								
Unknown		A						
Do		A						
Do		B						
Do		C	Fall wool					
CAPE COLONY.								
J. G. Steyn, Zwellendam.	26629	1	Merino	Wether	4 yrs		3 11	3
Do	26629	2	do	do	3 yrs		4 13	3
Do	26629	3	do	do	3 yrs		5 3	3
Do	26629	13	do	do	3 yrs		5 15	3
Do	26629	36	do	Ewe	3 yrs		4 12	2.50
Do	26629	41	do	do	3 yrs		4 12	2.50
Do	26629	43	do	do	4 yrs		8 0	2.50
A. N. Robertson, George.		4	do	Wether	2 yrs		4 5	3
H. P. Beyers, Caledon		6	do	do	12 mos		2 5	3
S. P. du Toit, Caledon	26630	7	do	do	3 yrs		4 8	3
Do	26630	28	do	do	12 mos		5 12	3
Donald Robertson	26631	8	do	Ewe	4 yrs		4 13	3
Do	26631	9	do	Wether	4 yrs		3 13	3.50
Do	26631	11	do	do			3 4	3.50
F. H. Robertson, George.	26632	14	do	Ewe	4 yrs		3 6	3
Do	26632	15	do	Wether	4 yrs		5 5	3
J. N. Vander Bye, Bredesdorp.		16	do	Ewe	14 mos		5 13	2.90
Do		17	Rambouillet	do	14 mos		4 4	3.50
Do		18	Merino	do	14 mos		6 3	3.50
Do		19	Rambouillet	do	14 mos		7	2.90
Do		20	do	do	2 yrs		18 1	3.60
P. V. Vander Bye, Caledon.	26628	22	do	do	15 mos		5 2	2.40
Do	26628	23	do	do	15 mos		4 12	2.40
Do	26628	24	do	do	15 mos		6 2	2.70
Do	26628	25	do	do	15 mos		6 12	2.50
C. H. Hutton, Middlebury.	26624	26	do	do	3 yrs		7 4	3.50

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2 R} = E = \frac{R}{P}$.			Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
3.876	1.526	1/655	17.683	272.118	4.706	23.53	18.776	21,259	90,814	
2.505	.986	1/1013	19.50	310.93	8.258	41.29	49.72	56,275	136,281	
2.060	.811	1/1233	6.125	94.321	6.240	31.20	23.09	26,132	83,770	
2.424	.954	1/1047	5.733	88.473	5.808	29.04	15.61	17,660	60,845	
2.119	.834	1/1198	10.108	157.201	5.566	27.83	35.98	40,730	146,300	
2.739	1.078	1/927	14.16	218.52	7.432	37.16	30.199	34,180	91,980	
2.894	1.139	1/877	10.620	163.890	5.050	25.25	20.28	22,960	90,940	
2.698	1.062	1/941	4.950	77.390	5.582	27.91	10.88	12,315	34,368	
4.702	1.851	1/540	36.278	559.854	8.982	44.91	26.25	29,714	66,165	
2.835	1.116	1/896	17.100	263.893	4.808	24.04	34.04	38,528	160,268	
4.013	1.580	1/633	18.425	284.340	6.782	33.91	18.30	20,495	61,100	
3.825	1.505	1/665	25.116	387.598	8.000	40	27.46	31,087	77,718	
2.611	1.028	1/973	14.516	224.015	7.492	37.46	34.06	38,559	102,926	
3.000	1.181	1/846	10.133	155.370	5.476	27.38	17.967	20,335	74,272	
2.866	1.136	1/880	11.666	180.030	8.058	40.29	22.72	25,720	63,690	Fine.
7.516	2.959	1/337	40.441	624.090	6.350	31.75	11.45	12,960	40,830	Coarse.
4.103	1.615	1/619	18.640	287.650	6.100	30.50	17.71	20,050	65,740	
2.411	.949	1/1053	9.133	150.940	7.400	37.00	25.13	28,455	76,895	
2.202	.866	1/1153	6.066	93.612	8.058	40.29	20.01	22,650	56,330	
1.8275	.719	1/1390	4.700	72.532	6.482	32.41	22.51	25,484	78,631	
2.058	.810	1/1234	5.016	77.408	6.224	31.12	18.94	21,446	68,916	
2.093	.824	1/1213	7.816	110.619	4.950	24.75	28.54	32,310	130,546	
1.834	.722	1/1385	4.491	69.406	6.550	32.75	21.363	24,179	73,829	
2.043	.804	1/1243	5.308	81.914	7.666	38.33	20.347	23,029	95,046	
2.119	.834	1/1198	5.308	81.914	6.758	33.79	19.35	21,405	64,830	
2.116	.833	1/1200	6.041	93.226	7.574	37.87	21.58	24,434	64,519	
1.735	.683	1/1463	4.825	74.461	7.000	35	25.64	29,017	82,913	Washed.
1.907	.750	1/1333	5.250	81.019	7.490	37.45	23.09	26,142	69,807	
1.885	.742	1/1347	6.316	97.470	7.558	37.79	28.44	32,188	85,180	
1.6495	.649	1/1540	4.266	65.834	7.258	36.29	25.09	28,410	78,285	
2.210	.871	1/1148	4.833	74.584	4.566	22.83	15.83	17,918	78,492	
2.380	.937	1/1067	4.100	63.272	7.232	36.16	11.581	13,106	36,248	
1.562	.615	1/1626	5.525	85.263	6.200	31	36.231	41,007	132,282	
1.654	.651	1/1535	3.650	56.328	7.316	36.58	21.34	24,161	66,049	
1.692	.666	1/1500	4.741	73.164	7.200	36	26.49	29,989	83,304	
1.956	.770	1/1298	4.325	66.744	5.200	26	18.08	20,472	78,732	
1.844	.726	1/1377	5.708	88.087	6.800	34	26.85	30,400	89,410	
1.725	.679	1/1472	4.833	74.584	5.250	26.25	25.98	29,400	112,040	
2.159	.850	1/1176	6.150	94.908	5.882	29.41	21.11	23,895	81,239	
1.669	.657	1/1521	3.425	52.855	6.440	32.20	19.67	22,266	69,149	
2.002	.788	1/1268	4.458	68.797	6.200	31	17.39	20,142	64,974	
2.126	.837	1/1194	4.833	74.584	6.450	32.25	17.10	19,364	60,041	
2.010	.791	1/1263	4.625	71.374	5.474	27.37	18.31	20,730	75,742	
1.845	.726	1/1376	4.658	71.883	6.908	34.54	21.89	24,780	71,743	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
CAPE COLONY—cont'd.						*Pounds.*	*Lbs. oz.*	*Inches.*
P. K. Albubyn		27	Rambouillet	Ram	2 yrs		5 8	2.80
H. P. Beyers, Caledon		29	do	Wether	12 mos		4 12	3.75
W. R. Southey, Middlebury.	26621	30	do	Lamb	9 mos		5 5	2.20
S. P. du Toit, Caledon		31	do	Wether	12 mos		5 4	3.50
Do		32	do	do	12 mos		6 2	3
P. K. Albubyn		33	do	Ram	2 yrs		5 3	3.50
J. S. de Wit, Caledon		34	Merino	Wether	12 mos		7 0	2.50
H. P. Beyers, Caledon		35	do	do	12 mos		4 10	3
G. I. Delport, Zwellendam.		38	do	Ewe	3 yrs		6 0	2.50
Do		39	do	Wether	3 yrs		4 8	2
Do		40	do	do	4 yrs		4 15	2.50
Do		42	do	do	4 yrs		5 9	3.50
P. J. Alport, Beaufort West.	26626	45	do	Ram	2 yrs		11 13	2.50
W. Joander & Son, Ceres		46	do	do	2 yrs		10 4	3.50
Jobs H. Van Dyk, Ceres		47	do	do	2 yrs		6 8	3.70
A. Ohlison, Ceres		48	do	Ewe	1 yr		6 8	3
Do		50	do	do	2 yrs		9 2	2.50
C. G. de Villiers, Beaufort West.		51	do	do	14 mos		5 5	
W. J. Merur, Ceres		54	do	do	2 yrs		7 9	2.50
W. & A. Wieber, Beaufort West.		56	do	do	3 yrs		6 3	3
Do		57	do	do	3 yrs		7 11	3.50
Do		58	do	do	3 yrs		7 4	3
Do		59	do	do	3 yrs		8 10	2.50
Do		60	do	do	3 yrs		5 14	2.50
Battenhauper Bros		61	do	Wether	2 yrs		7 10	3.10
M. & P. Wieber, Beaufort West.		62	do	Ewe	2 7/12 yrs		8 6	3.60
Wm. Jansen Van Rexburg, Bretstown.		63	do	Wether	2 yrs		10 0	3.50
Do		64	do	do	12 mos		10 2	3.50
F. C. Bagley, Bretstown		65	do	Ewe	1 yr		7 15	4
Molton & Jackson, Beaufort West.		66	do	do	14 mos		5 14	3
Do		67	do	do	1 yr		5 14	2.42
Do		68	do	do	1½ yrs		4 4	2.42
Do		69	do	do	1 yr		6 4	3
P. D. de Villiers, Beaufort West.	26620	71	do	Wether	3 yrs		8 10	3
Do	26620	72	do	Lamb	14 mos		5 12	3.40
Do	26620	74	do	Ewe	18 mos		6 2	2.30
Do	26620	75	do	do	3 yrs		6 10	3
P. J. Van Wyk, Ceres		76	do	do	2 yrs		8 0	2.50
C. P. du Plesses, Ceres		77	do	Wether	2 yrs		6 6	2.25
A. Ohlison, Ceres		78	do	do	1½ yrs		5 12	2
Jobs A. Van Dyk, Ceres		79	do	do	18 mos		5 4	2.70
W. J. Van Wyat, Ceres		80	do	do	2 yrs		10 0	3.50
Walter Rubridge, Aberdeen.	26622	81	do	Ewe	12 mos		6 4	3
Rubidge Bros., Groff Reinet.	26625	82	do	do	3 yrs		6 14	3
Do	26625	84	do	do	36 mos		6 11	3
Do	26625	88	do	do	3 yrs		14 14	4
P. J. Alport & Co., Beaufort West.	26626	83	do	Ra	18 mos		5 5	2.10
Do	26626	86	do	Ewe	3 yrs		8 7	3.50
Do	26626	87	do	Ram	1½ yrs		11 11	3.10
Do	26626	89	do	Ewe	14 mos		9 6	3.40
Do	26626	90	do	do	4 yrs		9 3	3.50
J. C. T. Musts, Beaufort West.	26626	91	do	Lamb	9 mos		5 15	3.20
P. J. Van Wyk, Ceres		85	do	Wether	2 yrs		7 11	3
J. C. T. Musts, Beaufort West.		92b	do	Lamb	9 mos		6 4	2.60
Do		93	do	Ewe	20 mos		8 5	3.70
Do		94	do	do	3 yrs		8 8	2.60
A. J. de Jager, Beaufort West.		95	Rambouillet	do	13 mos		3 7	2.70

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
1.865	.734	1/36	3.941	61.818	6.316	31.58	18.12	20,518	64,972	
2.012	.792	1/32	4.266	65.834	4.966	24.83	16.86	30,255	121,835	
2.408	.948	1/26	6.300	97.223	5.458	37.29	17.383	19,675	52,775	
1.827	.719	1/36	4.616	71.225	6.616	33.08	22.12	25,032	75,703	
2.121	.835	1/30	6.258	96.575	7.658	38.29	22.25	25,291	65,790	
1.745	.687	1/38	4.158	64.167	6.050	30.25	21.84	24,727	81,741	
2.063	.812	1/31	4.966	77.633	5.566	27.83	18.66	21,130	75,920	
2.063	.812	1/31	4.591	70.949	5.966	29.83	17.251	19,534	65,486	
2.447	.963	1/27	5.158	79.600	5.258	26.29	13.782	15,598	59,335	
2.096	.825	1/31	5.100	78.704	7.050	35.25	18.574	21,070	59,638	
2.050	.807	1/32	5.200	80.248	7.174	35.87	19.797	22,407	62,468	
2.180	.858	1/29	5.300	81.791	6.290	31.45	17.843	20,195	64,215	
1.928	.759	1/33	5.291	81.752	7.540	37.70	22.774	25,776	86,075	
1.931	.760	1/36	4.066	62.747	5.574	27.87	33.69	38,130	136,800	
2.068	.814	1/32	5.888	90.788	7.540	37.70	22.009	24,911	66,077	
2.256	.888	1/28	5.008	77.285	6.540	32.70	15.743	17,818	54,492	
1.812	.713	1/40	3.825	59.028	6.232	31.16	18.63	21,096	67,703	
2.017	.794	1/32	4.783	73.812	6.782	33.91	18.728	21,295	61,355	
2.233	.879	1/27	5.283	81.528	7.490	37.45	17.034	19,235	51,362	
1.809	.712	1/40	4.291	66.250	6.050	30.25	20.979	23,745	77,597	
1.911	.752	1/36	5.888	90.788	7.740	38.70	20.473	23,171	59,875	
1.784	.702	1/40	4.425	68.288	5.858	29.29	22.245	25,119	89,560	
1.799	.708	1/41	5.408	83.335	5.408	27.04	26.78	30,266	111,900	
1.784	.702	1/40	4.708	72.655	6.470	32.35	23.663	12,241	37,841	
1.695	.667	1/37	6.183	105.418	5.550	27.75	34.43	38,970	140,400	
1.824	.521	1/48	5.741	88.597	5.340	26.70	52.40	59,305	222,150	
1.900	.748	1/34	4.608	71.112	5.874	29.37	20.42	23,115	78,703	
1.847	.727	1/34	4.591	70.949	6.916	34.58	27.107	24,370	70,476	
1.862	.733	1/33	4.933	77.127	5.616	28.58	22.765	25,706	90,153	
1.916	.754	1/33	4.525	69.831	6.382	31.91	19.721	22,372	69,951	
1.855	.730	1/35	6.891	106.444	6.524	32.62	32.04	36,265	111,150	
1.931	.760	1/34	3.875	59.800	4.400	22	16.62	18,818	85,544	
1.654	.651	1/39	4.025	62.115	5.808	29.04	23.54	26,644	91,746	
1.761	.693	1/37	5.941	92.683	6.250	31.25	30.65	34,692	111,080	
1.860	.732	1/34	5.908	92.174	5.724	28.62	27.32	30,925	85,830	
2.005	.789	1/32	5.200	80.248	4.674	23.37	20.69	23,420	100,250	
1.550	.610	1/43	5.125	79.090	6.116	30.58	34.18	38,630	126,300	
1.748	.688	1/37	6.183	96.418	6.266	31.33	32.37	36,645	116,950	
2.228	.877	1/29	5.783	89.245	4.808	24.04	18.64	21,095	87,755	
1.692	.666	1/38	5.266	81.266	5.016	25.08	29.43	33,310	132,850	
1.791	.705	1/40	5.233	80.757	5.490	27.45	26.10	29,540	107,600	
1.819	.716	1/39	5.241	80.880	7.590	37.95	25.34	28,683	75,584	
1.832	.721	1/38	5.100	78.704	8.224	41.12	44.54	50,413	122,650	
1.890	.744	1/34	5.666	87.439	6.982	34.66	47.96	54,289	156,650	
1.933	.761	1/33	6.041	93.226	6.924	34.62	25.86	29,278	84,570	
1.565	.616	1/42	4.875	75.232	5.690	28.45	31.84	36,045	126,700	
1.860	.732	1/34	4.500	69.445	6.782	33.91	20.848	23,596	69,586	
1.606	.632	1/39	5.341	82.424	5.966	29.83	33.13	37,501	125,710	
1.733	.682	1/37	4.725	72.917	5.082	25.41	25.17	28,490	112,150	
1.931	.760	1/34	4.725	72.917	6.600	33	20.274	22,947	69,537	
1.946	.766	1/33	5.225	80.634	10.266	51.33	22.076	24,985	48,676	
2.015	.793	1/32	7.191	111.074	8.008	40.04	28.337	32,073	80,472	
1.944	.765	1/33	5.900	92.050	4.800	24.00	24.97	28,270	117,800	
1.880	.740	1/34	7.266	112.181	5.958	29.79	32.885	37,220	125,220	
1.941	.764	1/33	4.766	73.550	5.740	28.70	20.240	22,908	79,820	
1.880	.740	1/34	5.333	82.300	6.774	33.87	24.142	27,324	80,674	
2.114	.832	1/30	4.433	68.411	4.708	23.54	15.871	17,963	77,370	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
CAPE COLONY—cont'd.						*Pounds.*	*Lbs. oz.*	*Inches.*
John Frost, Queenstown		96	Merino	Ewe	18 mos.		8 10	3.20
Do		97	Tasmanian blood.	Ram	4 yrs.		12 11	3.22
Do		99	Australian blood.	Ewe	18 mos.		7 9	3.70
Robt. P. Scott, Queenstown.		100	Rambouillet	Lamb	13 mos.		6 0	2.70
Do		101	Merino	Ewe	2 yrs.		7 14	2.70
Do		102	do	Wether	3 yrs.		8 5	2.70
Do		103	do	do	4 yrs.		8 10	3.70
Do		104	Rambouillet	Lamb	13 mos.		6 6	2.30
J. W. Butler, Stuttenheim		105	Merino	Wether	4 yrs.		8 13	2.30
W. R. Southy, Middleburg.	26621	106	do	Lamb	9 mos.		6 13	2.40
Do	26621	107	do	Ewe	1½ yrs.			4.50
Do	26621	108	do	do	1½ yrs.		13 12	3.90
Do	26621	109	do	do	19 mos.		8 10	3.90
Do	26621	110	do	do	18 mos.		8 12	3.58
George Blaine, Stuttenheim.		111	do	Ram	13 mos.		8 12	2.77
Do		112	do	Ewe	2 yrs.		8 12	4
Do		113	do	do	2 yrs.		7 1	2.50
Do		114	do	do	2 yrs.		7 14	4
Do		115	do	do	2 yrs.		8 0	4
J. W. Butler, Stutenheim		116	do	Wether	3 yrs.		7 6	3.50
Do		117	do	do	4 yrs.		7 6	3.50
Do		118	do	do	3 yrs.		6 0	3.50
C. H. Hutton, Middleburg	26624	119	do	Ewe	3 yrs.		7 2	3.50
Do	26624	133	do	do	2 yrs.		7 0	3
Do	26624	135	do	do	3 yrs.		7 11	3
A. N. Robertson, George.		120	do	Wether	2 yrs.		6 6	3.50
Geo. King & Sons, Bedford.	26623	121	Spanish Merino.	Ewe	1½ yrs.		6 12	3.70
Do	26623	122	Tasmanian	Ram	3 yrs.		11 14	2.50
Do	26623	123	Spanish Merino.	Ewe	5 yrs.		8 5	3.20
Do	26623	136	do	do	1½ yrs.		8 7	3.80
J. W. Butler, Stuttenheim		124	Merino	Wether	3 yrs.		7 10	3
Walter Rubridge, Aberdeen.	26622	126	Karroo	Ewe	2 yrs.		5 10	3.50
Do	26622	127	do	do	2 yrs.		4 12	3.50
Do	26622	128	do	do	14 mos.		5 11	3.40
Do	26622	129	do	do	2 yrs.		6 3	3.50
G. J. Delport, Zwellendam.		130b	Merino	Wether	4 yrs.		5 11	3.60
J. J. Gerucke, Morsel Bay		131	do	Ewe	4 yrs.		5 0	3
Altern Muller, Morsel Bay.		132	Australian	do	2 yrs.		8 8	4.20
C. H. Hutton, Middleburg	26624	133	Merino	do	2 yrs.		7 0	3
Do	26624	135	do	do	3 yrs.		7 11	3
GUATEMALA.								
Unknown		1	Black native					3
Do		1						
Do		2	White native					3
Do		3	do					3
Do		4	White, cross Merino.					3
Do		5	White native					3
Do		6	Black native					2.25
Do		7	White native					
Do		7						
Do		8	Black native					2.25
Do		9	Coarse native					3.30
Do		9						
Do		10	Black native	Ram				3.50
Do		10						
Do		11	Native mountain.					1

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2} = \frac{S}{S'}$	$18109\frac{S}{D^2} = R.$	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
1.801	.709	1/36	4.475	69.059	6.732	33.66	22.074	24,983	74,224	
2.426	.955	1/26	5.908	93.175	6.208	31.04	16.061	18,178	57,230	
1.654	.651	1/38	4.075	62.886	6.432	32.16	23.832	26,974	83,875	
1.878	.739	1/33	4.875	75.232	5.790	28.95	22.115	25,030	86,462	
2.124	.836	1/29	5.441	83.967	7.632	38.16	19.296	21,840	57,234	
2.119	.834	1/29	4.750	72.303	6.232	31.16	16.925	19,156	61,479	
1.880	.740	1/33	5.483	84.615	6.390	31.95	24.82	28,092	87,929	
2.053	.808	1/30	5.275	81.405	11.766	58.83	20.02	22,665	38,525	
1.743	.686	1/36	4.208	64.939	7.900	34.50	22.16	25,084	72,703	
1.707	.672	1/37	4.166	64.291	7.478	37.29	22.35	25,891	69,431	
1.702	.670	1/37	5.125	79.090	8.558	42.79	28.30	32,039	74,873	
1.817	.715	1/35	4.283	65.096	6.532	32.66	20.75	23,495	71,930	
1.659	.653	1/38	3.525	54.401	7.090	35.45	20.49	23,195	65,425	
1.733	.682	1/36	3.283	50.664	5.658	28.29	17.49	19,793	69,973	
1.779	.700	1/36	5.516	85.124	5.050	25.25	27.88	31,562	124,998	
1.681	.662	1/38	6.100	94.137	5.824	29.12	34.53	39,091	134,240	
1.895	.746	1/33	6.358	98.118	6.374	31.87	28.32	32,062	100,603	
1.618	.637	1/39	5.775	89.121	6.650	33.25	35.29	39,947	120,142	
1.521	.599	1/42	5.641	87.053	5.350	26.75	39.01	44,156	165,070	
1.664	.655	1/38	5.333	82.300	5.800	29	30.81	34,878	120,271	
1.695	.667	1/37	6.433	99.176	6.482	32.41	35.01	40,547	125,109	
1.715	.675	1/36	5.933	92.560	4.916	24.58	32.27	36,530	148,620	
1.695	.667	1/37	4.733	73.04	6.716	33.58	26.35	29,830	88,840	
2.241	.882	1/28	6.083	93.87	6.324	31.62	19.38	21,933	69,369	
1.672	.658	1/38	4.675	103.01	7.208	36.04	26.75	30,285	84,028	
1.872	.737	1/34	5.558	85.77	7.140	35.70	25.96	28,720	80,450	
1.867	.735	1/35	4.941	77.251	7.400	37	22.68	25,670	69,370	
1.502	.591	1/43	4.383	67.639	6.266	31.33	31.08	35,180	112,300	
1.898	.747	1/33	5.041	77.794	6.816	34.08	22.38	25,340	74,355	
1.969	.775	1/32	5.650	77.192	5.766	28.83	23.31	26,391	91,540	
1.634	.643	1/39	4.583	70.726	6.758	33.79	27.46	31,082	91,990	
1.398	.550	1/45	4.850	73.84	7.674	38.37	39.70	44,938	117,150	
1.646	.648	1/39	4.466	68.92	6.424	32.12	26.37	29,852	92,934	
1.652	.650	1/39	4.858	74.97	6.432	32.16	28.47	32,239	100,250	
1.654	.651	1/38	5.450	84.10	7.532	37.66	31.87	36,078	95,794	
2.330	.917	1/27	6.891	105.44	6.974	34.87	20.30	22,982	65,918	
1.888	.743	1/34	5.866	90.52	7.950	39.75	26.33	29,802	74,970	
1.547	.609	1/41	4.908	76.74	7.390	36.95	32.81	37,139	100,550	
2.241	.882	1/28	6.083	93.87	6.324	31.62	19.38	21,933	69,369	
1.672	.658	1/38	4.675	103.01	7.208	36.04	26.75	30,285	84,028	
2.756	1.085	1/21	.....	.....	.....	.....	.....	.....	.....	Fine.
4.641	1.827	1/12	.....	.....	.....	.....	.....	.....	.....	Coarse.
3.727	1.467	1/15	.....	.....	.....	.....	.....	.....	.....	
4.397	1.731	1/12	.....	.....	.....	.....	.....	.....	.....	
2.378	.936	1/26	.....	.....	.....	.....	.....	.....	.....	Probably coarse.
2.586	1.018	1/25	.....	.....	.....	.....	.....	.....	.....	
3.193	1.257	1/18	.....	.....	.....	.....	.....	.....	.....	Washed.
2.927	1.152	1/22	.....	.....	.....	.....	.....	.....	.....	
1.812	.713	1/35	.....	.....	.....	.....	.....	.....	.....	
2.899	1.141	1/22	.....	.....	.....	.....	.....	.....	.....	Coarse.
2.187	.861	1/29	.....	.....	.....	.....	.....	.....	.....	
4.075	1.604	1/16	.....	.....	.....	.....	.....	.....	.....	Do.
3.043	1.434	1/17	.....	.....	.....	.....	.....	.....	.....	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
GUATEMALA—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Unknown	22800a	.....	Merino cross..	.....	.....	.....	.....	3.50
Do	22800b	.....	.....do	.....	.....	.....	.....	.....
MEXICO.								
Government Mexican Republic.	.....	A	Merino and native Mexican cross.	.....	.....	.....	.....	2.50
Agustin Covarrubias, Quilupam.	.....	B	Native Mexican.	.....	.....	.....	.....	3
Do	.....	B	.....do	.....	.....	.....	.....	6
Do	.....	Ca	Black native Mexican.	.....	.....	.....	.....	.....
Do	.....	Cb	....do	.....	.....	.....	.....	3.25
Farm of Santa Cruz de Ahualulco, State of Jalisco.	.....	D	Merino	.....	6 mos..	.....	.....	2
Santiago Graf, Villa Guerrero, District of Mexico.	26339	E	Native Mexican.	.....	.....	.....	.....	1
A. Mercado, Morelia, State of Michoacan.	26358	F	.....	.....	.....	.....	.....	.....
Francisco M. de Lara, San Luis Obispo.	.....	G	Native Mexican, black.	.....	.....	.....	.....	.....
Do	.....	H	.....	.....	.....	.....	.....	2.50
Government of State of Puebla.	26381	I	Native Mexican.	.....	.....	.....	.....	9
Do	.....	I	.....	.....	.....	.....	.....	.....
Do	.....	I	.....	.....	.....	.....	.....	.....
Do	.....	J	Native Mexican.	.....	.....	.....	.....	3
Do	.....	J	.....	.....	.....	.....	.....	2
Do	.....	J	.....	.....	.....	.....	.....	3
Do	.....	K	Merino, cross native.	.....	.....	.....	.....	.....
Do	.....	L	.....do	.....	.....	.....	.....	.....
Matias Loberon, San Luis Obispo.	26397	M	.....do	.....	.....	.....	.....	.....
Farm of Santa Cruz de Ahualulco, State of Jalisco.	26349	N	Cashmere goat	.....	6 mos..	.....	.....	1.50
NEW SOUTH WALES.								
E. J. Allen, Stony Creek..	6172	83	Pure Merino..	Ewe	5½ mos..	50	3 10	3.80
Do	6173	84	.....do	....do ...	5½ mos..	48	5 6	3.3
Do	6174	85	.....do	....do ...	4½ yrs ...	76	10 8	2.51
Do	6175	86	.....do	....do ...	4½ yrs ...	77	7 0	3
Do	6176	87	.....do	....do ...	16 mos..	40½	5 8	3.98
Do	6177	88	.....do	....do ...	4½ yrs ...	71½	10 13	3.5
J. B. Billington, Brondley Park.	6178	89	.....do	....do ...	3 yrs	.....	10 10	4.6
E. M. Bowman, Wargundy.	6179	90	.....do	....do ...	5 yrs	83	9 10	2.9
G. Bruce, Loombart.....	6180	91	Australian Merino.	....do ...	2½ yrs ...	76	12 2	3.8
Do	6181	92	.....do	....do ...	3 yrs	102	17 9	3.2
Do	6182	93	.....do	Ram....	2 yrs	101	16 4	2.8
Do	6183	94	.....do	....do ...	Aged ...	117	21 15	3.3
Do	6184	95	.....do	....do ...	3 yrs	107	22 15	3.3
Do	6185	96	.....do	Ewe	1½ yrs ...	75	21 5	4.3
Do	6185	96	.....do	....do ...	1½ yrs ...	.....	.....	.....
F. Campbell, Yarralumla	.....	97	Pure Merino..	....do ...	2 yrs	.....	18 0	.....
Collaroy Co., Collaroy...	6186	99	.....do	....do ...	3½ yrs ...	97	17 7	3.8
Do	6187	100	.....do	....do ...	1½ yrs ...	92	15 0	3.5
Do	6188	101	.....do	Ram....	1½ yrs ...	145	17 9	4
Do	6189	102	.....do	....do ...	3½ yrs ...	135	19 3	4.3
Do	6189	102	.....do	....do ...	3½ yrs ...	.....	.....	.....
G. H. Cox, Burrundulla..	6190	103	Saxon Merino	Ewe	3½ yrs ...	104	12 3	2.6
Do	6191	104	.....do	Ram....	4½ yrs ...	128	24 7	3.2
Do	6192	105	.....do	Ewe	3 yrs	110	17 0	2.1

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2 R}$		$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
5.119	2.015	1/50								
3.597	1.416	1/70								
2.375	.934	1/107	16.39	153.03	6.416	32.08	46.57	52,708	164,320	
2.916	1.148	1/87	14.925	231.32	6.358	31.79	28.07	31,770	99,950	Fine.
5.822	2.292	1/35	60.783	938.02	8.990	44.95	28.68	32,460	71,920	Coarse.
4.649	1.883	1/44	39.741	623.29	7.232	36.16	29.42	33,305	92,102	
3.831	1.508	1/53	29.40	463.71	7.758	38.79	32.05	36,275	93,515	
2.031	.799	1/125	5.391	83.297	4.016	20.08	20.91	23,665	11,787	
2.068	.814	1/123	8.500	131.174	4.774	23.87	31.80	35,992	150,770	
2.378	.936	1/107	16.39	253.036	4.683	19.87	13.25	14,996	75,474	
2.642	1.040	1/97	19.13	305.32	5.990	29.95	42.85	490,630	165,720	
3.607	1.420	1/72	16.56	250.612	5.800	29	20.36	23,040	79,480	
2.695	1.061	1/93	9.860	162.16	7.036	35.33	21.72	24,585	69,585	Fine.
4.392	1.729	1/58								Coarse.
3.691	1.458	1/68	13.21	204.47	6.600	33	15.54	17,595	53,331	Washed.
2.319	.913	1/109	9.980	165.01	1.150	30.75	29.69	33,605	109,252	White.
3.379	1.330	1/75	8.270	120.762	6.558	32.79	11.58	13,112	40,000	Gray.
2.825	1.112	1/89	16.32	251.85	6.640	33.20	32.71	37,032	111,500	Brown
3.065	1.206	1/82	12.70	195.99	6.150	30.75	21.63	24,485	79,615	
3.033	1.194	1/83	12.25	189.04	6.066	30.33	21.30	24,115	79,508	
2.337	.920	1/108	6.566	101.328	5.966	29.83	19.23	21,771	72,980	
2.576	1.014	1/98	11.31	174.53	5.950	29.75	27.27	30,860	103,700	
1.854	.730	1/137	5.223	80.60	8.300	41.50	24.31	27,516	66,306	
1.411	.555	1/181	4.508	69.56	6.516	32.58	36.22	41,008	125,855	
2.129	.838	1/119	6.150	94.90	7.216	36.08	23.26	24,570	68,100	
2.058	.810	1/124	5.891	91.01	6.258	31.29	17.67	20,006	63,940	
2.048	.806	1/126	5.058	78.05	6.990	34.95	20.20	22,860	65,428	
1.845	.730	1/139	5.675	87.57	6.866	34.33	26.67	30.190	87.941	
1.814	.714	1/140	5.691	87.92	6.524	32.62	27.66	31,311	76,247	
1.991	.784	1/128	5.766	88.98	5.282	26.16	23.27	26,340	72,845	
2.147	.845	1/118	4.908	76.741	5.474	27.37	17.03	19,281	70,446	
2.322	.914	1/109	6.041	93.22	4.576	22.58	17.92	20,289	89,857	
1.875	.738	1/136	5.458	84.22	5.250	26.25	24.84	28,769	107,100	
2.241	.882	1/113	6.016	92.84	4.932	24.66	19.16	21,692	87,968	
1.751	.689	1/145	5.116	78.95	5.890	29.45	26.69	30,216	102,600	
2.147	.845	1/118	4.483	69.18	7.408	37.04	15.20	17,611	47,549	Unwashed.
1.865	.734	1/136	4	61.72	5.440	27.20	17.98	20,351	74,821	Washed.
2.190	.862	1/116	6.141	94.77	4.340	21.70	20.48	23,187	106,850	
2.228	.877	1/114	5.775	88.12	7.532	37.66	18.61	21,067	56,941	
1.944	.765	1/131	5.716	88.21	5.900	29.50	24.20	27,390	92,848	
1.969	.775	1/129	6.283	96.95	5.832	29.16	25.92	29,340	100,620	
1.674	.659	1/152	4.450	68.67	7.174	35.87	25.40	28,756	80,170	Unwashed.
2.055	.809	1/124	4.907	76.72	4.208	21.04	18.59	21,041	100,000	Washed.
1.890	.744	1/134	4.066	62.74	6.040	30.20	22.92	25,950	85,927	
2.329	.917	1/109	6.391	98.72	5.758	28.79	18.85	21,332	74,111	
1.982	.780	1/128	4.891	75.579	5.282	26.41	19.92	22,546	85,372	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
NEW SOUTH WALES—c't'd.								
						Pounds.	*Lbs. oz.*	*Inches.*
G. H. Cox, Burrundulla..	6193	106	Saxon Merino.	Ram....	2¼ yrs...	110	14 6	3.2
W. & F. C. Dickson, Yarrawin.	6197	107	Pure Merino..	....do...	3 yrs....	130	18 6	3.94
Do	6198	108	.....do.....	....do...	14 mos..	100	17 10	3.90
V. J. Dowling, Lue Mudgee.	6199	109	Lue-bred Merino.	Ewe....	2⅛ yrs...	77½	14 13	3
Do	6200	110	.....do.....	....do...	3 yrs....	92	11 12	3.5
Do	.....	111	.....do.....	....do...	13 mos..	75	.....	.....
Do	.....	112	.....do.....	....do...	3 yrs....	101½	.....	.....
Do	6201	113	.....do.....	Ram....	2½ yrs...	112½	17 0	3
Do	6202	114	.....do.....	....do...	14 mos..	81½	14 15	3
Dullmuty & Deakin, Killoola, Peel.	6203	115	Cassilis-bred Merino.	Ewe....	1¼ yrs..	60	15 1	3.5
Do	6204	116	.....do.....	....do...	6 yrs....	70	9 7	3
Do	6205	117	.....do.....	....do...	28 mos..	78	8 0	3.5
Do	.....	118	.....do.....	....do...	6 yrs....	92	.....	.....
Duntroon estate, Queanbeyan.	6206	119	Lee's Larras Lake bred Merino.	Ram....	4 yrs....	233	11 4	3
Do	6206	119	.....do.....	....do...	4 yrs....	43	5 15	2.72
Do	6207	120	Pure Merino..	Ewe....	16 mos..	42	5 15	3.32
W. N. Faithful, Springfield.	6208	121	.....do.....	Ram....	36 mos...	.....	14 6	3.5
Do	6209	122	Goulburn Merino.	....do...	.....	.....	14 1	3
Do	6210	123	.....do.....	....do...	.....	.....	11 11	3.5
C. Fetherstonbaugh, Goorianawa.	6211	124	Goorianawa Merino.	Ewe....	Aged...	109	11 8	3.50
Do	6212	125	Australian Merino.	....do...	Aged...	111	9 4	3
J. & James Gibbson, Berthong.	6213	126	Pure Merino..	....do...	2½ yrs...	65¼	8 10	3.70
Do	6214	127	.....do.....	....do...	3½ yrs...	71	11 7	3.7
Do	6214	127	.....do.....	....do...	3½ yrs...	71	11 7	3.74
Do	6215	128	.....do.....	Ram....	17 mos..	69½	10 1	3.70
Do	6216	129	.....do.....	....do...	17 mos..	65½	10 11	3.90
L. McBean Grant, Butherwah.	6217	130	Colombo ram from Butherwah ewe.	Ewe....	16 mos..	64	10 5	4.10
Do	6218	131	Merino.....	....do..	1½ yrs...	.....	.....	.....
Do	6218	131	.....do.....	....do...	16 mos..	74	10 6	4.60
Do	6219	132	Colombo ram from Butherwah ewe.	....do...	16 mos..	73	10 10	4.60
Do	6220	133	.....do.....	....do...	16 mos..	64	11 3	4.60
Chas. Castle Hall, Yeumburra.	6221	134	Australian-Vermont, three-fourths Merino.	Ram....	15 mos..	80	9 10	2.80
Do	6221	134	.....do.....	....do...	4 yrs....	.....	9 10	.....
Do	6222	135	.....do.....	....do...	5 yrs....	50	5 14	2.80
Do	6223	136	Australian Merino.	....do...	5 yrs....	120	19 12	.....
Do	6223	136	.....do.....	....do...	8 yrs....	120	19 12	4.40
Do	6224	137	.....do.....	Ewe....	16 mos..	60	8 0	3.30
R. F. Horsley, Yabtree..	6225	138	Pure Merino..	....do...	14 mos..	70	7 4	3.70
F. W. Hume, Farengo, Burrowa.	6226	139	.....do.....	....do...	3 yrs....	.....	21 9	6.20
Do	6227	140	.....do.....	Ram....	3 yrs....	.....	42 13	10
Do	6228	141	.....do.....	Ewe....	14 mos..	.....	27 7	6.20
Do	6229	142	.....do.....	Ram....	2 yrs....	.....	24 7	6.20
H. R. F. Hume, Everton, Rye Park.	6230	143	Saxon Merino	Ewe....	....do...	.....	5 12	3
Do	6231	144	.....do.....	Ram....	....do...	.....	8 14	3
Do	6232	145	.....do.....	Ewe....	....do...	.....	8 1	3
Do	6233	146	.....do.....	....do...	....do...	.....	6 8	3
Do	6234	147	.....do.....	Ram....	....do...	.....	9 6	3
Do	6235	148	.....do.....	....do...	....do...	.....	6 1	2.55
Andrew Loder, Colley Creek.	6236	149	Spanish Merino.	Ewe....	14 mos..	74	10 11	2.51
Do	6237	150	.....do.....	....do...	2 yrs....	82	11 10	3.51

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R.$	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
2.012	.792	1/32	3.891	60.147	7.824	39.12	15.414	17,446	44,596	
2.0855	.821	1/31	5.466	84.353	6.874	34.37	20.117	22,769	66,248	
1.943	.765	1/37	4.733	72.041	6.590	32.95	20.05	22,703	68,901	
2.2075	.869	1/29	4.491	69.406	6.990	34.95	14.74	16,682	47,751	
2.0195	.795	1/32	4.9083	76.746	8.475	42.38	19.255	21,794	51,431	
2.126	.837	1/30	5.749	88.730	6.750	33.75	20.812	23,566	69,826	
1.930	.760	1/38	3.950	61.957	8.174	40.87	16.966	19,203	45,864	
1.977	.778	1/32	5.783	89.245	5.008	25.04	23.67	26,795	107,005	
1.685	.663	1/37	5.258	81.143	5.608	28.04	29.63	33,535	119,601	
2.095	.823	1/31	4.500	69.445	7.292	36.46	16.401	18,566	50,824	
1.890	.744	1/34	4.350	67.130	4.116	20.58	14.758	16,698	81,125	Washed.
2.172	.855	1/30	3.625	55.941	5.182	25.91	12.29	13,910	53,700	Unwashed.
1.763	.694	1/36	4.983	77.899	7.025	35.13	25.651	29,032	82,577	
2.070	.815	1/31	5.400	83.334	5.890	29.45	20.163	22,821	77,466	Washed.
2.012	.792	1/32	4.716	72.778	6.700	33.50	18.63	21,096	62,974	
1.941	.764	1/37	6.425	109.152	7.108	35.04	27.286	30,882	88,135	
1.751	.689	1/36	4.775	73.689	5.350	26.75	24.91	28,208	105,450	
2.207	.869	1/29	5.091	78.666	8.140	40.70	16.72	16,869	46,504	
1.580	.622	1/40	3.633	56.065	6.624	33.12	26.284	26,353	79,571	
1.479	.582	1/43	4.408	68.025	4.474	22.37	32.24	36,492	163,100	Do.
1.7655	.695	1/36	4.708	72.655	6.391	31.95	24.166	27,352	83,016	Unwashed.
1.644	.647	1/39	4.250	65.587	6.050	30.25	25.159	28,476	94,135	
1.864	.734	1/34	4.892	75.596	6.875	34.37	22.513	25,480	74,126	
1.690	.665	1/38	5.691	87.925	5.712	28.56	31.88	36,080	126,300	
1.738	.684	1/37	4.833	74.584	6.958	34.79	25.60	28,975	83,282	Washed.
1.766	.695	1/36	5.266	81.266	6.690	33.45	27.01	30,575	91,410	Unwashed.
1.994	.785	1/32	5.320	82.115	4.950	24.75	21.40	24,220	97,900	
2.002	.788	1/32	5.033	77.671	4.890	24.45	20.09	22,740	93,007	
1.8695	.736	1/35	3.741	57.732	6.724	33.62	17.126	19,383	57,654	
1.801	.709	1/36	5.183	79.985	6.258	31.29	25.56	28,935	92,480	
1.699	.669	1/38	3.733	58.608	5.708	28.54	20.67	23,409	82,009	
2.131	.839	1/31	8.475	130.789	8.132	40.66	29.86	33,795	83,119	Washed.
2.507	.987	1/26	5.200	80.248	6.942	34.71	13.315	15,070	43,400	Unwashed.
1.8695	.736	1/35	3.517	54.275	6.342	34.71	16.472	18,220	57,464	
1.773	.698	1/36	4.075	62.454	7.416	37.08	20.74	23,474	63,377	
2.002	.788	1/32	6.792	103.906	5.933	29.66	27.049	30,615	100,330	
2.291	.902	1/28	5.475	84.492	7.574	37.87	16.68	18,920	49,880	
1.471	.579	1/44	4.741	78.164	4.700	23.50	35.05	39,675	176,385	
2.029	.799	1/32	5.583	86.158	5.424	27.12	21.698	24,558	90,554	
1.715	.675	1/38	4.833	74.582	6.932	34.66	26.290	29,760	86,000	
1.831	.721	1/35	4.800	74.074	6.250	31.25	22.900	25,925	82,970	
1.849	.728	1/35	4.516	69.69	6.850	34.25	21.134	30,113	87,922	
1.799	.708	1/36	5.133	79.114	5.916	29.58	25.37	28,725	97,098	
2.009	.791	1/32	5.508	85.001	6.575	32.87	21.835	24,713	75,204	
1.552	.611	1/40	5.658	87.316	6.474	32.37	37.583	42,537	131,400	
1.727	.6802	1/37	3.858	59.537	6.358	31.79	20.178	23,270	73,516	
1.788	.700	1/36	3.816	58,889	6.133	30.66	19.314	21,860	71,295	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
NEW SOUTH WALES—c't'd.								
						Pounds.	*Lbs. oz.*	*Inches.*
Andrew Loder, Colley Creek.	6238	151	Spanish Merino.	Ewe	4 yrs.	75	13 11	3.50
Do	6238	151	do	do	48 mos.	75	13 14	5.44
Do	6239	152	do	Ram	4 yrs.	117	18 4	3.5
Do	6240	153	do	do	23 mos.	96	17 11	4.1
Do	6241	154	do	do	12 mos.	85	12 10	3.50
John C. Manchee, Glen Moan.	6242	155	Pure Merino.	do	5 yrs.	160	17 0	2.5
Do	6243	156	Australian Merino.	Ewe	2 yrs.	80	13 8	2.53
Do	6244	157	do	do	2 yrs.	84	12 9	3.02
Do	5245	158	do	do	2½ yrs.	89	12 6	3.50
George Merriman, Ravensworth.	6246	159	Pure Merino.	Ram	5 yrs.	157	9 3	3.3
Do	6247	160	do	Ewe	2 yrs.	103	10 8	2.8
G. J. Mulholland, Oura.	6248	161	Three-fourths Tasmanian ewe by Havilah ram.	do	16 mos.	52	8 2	3.4
Do	6249	162	Pure Merino.	do	16 mos.	41	7 7	3.2
Do	6250	163	do	do	16 mos.	43	5 12	3.7
G. J. Mulholland, Rosewood Park.	6251	164	do	do	16 mos.	41	13 2	3.2
Andrew Murray, Bannockburn.	6252	165	American-Spanish Merino.	Ram	5 yrs.	129½	15 9	3.8
Do	6253	166	do	Ewe	4 yrs.	113	12 9	3.75
Argyle McCallum, Good Hope.	6254	169	Saxon Merino	Ram	2 yrs.	.....	9 15	3.8
Do	6255	170	do	Ewe	2 yrs.	43½	8 8	2.37
Do	6256	171	do	do	2 yrs.	43½	9 13	2.96
Do	6257	172	One-fourth Vermont Merino.	do	2 yrs.	43½	8 4	3.55
Peel River Land and Mineral Co.	6258	173	Pure Merino.	do	26 mos.	82	8 8	3
Do	6259	174	do	Ram	26 mos.	103	12 12	2.50
Do	6260	175	do	Ewe	26 mos.	82	8 10	3
Do	6261	176	do	Ram	26 mos.	103½	14 0	2.50
Richard H. Roberts, Tiverton.	6262	177	do	Ewe	3½ yrs.	104	9 10	3
Do	6263	178	do	do	16 mos.	76	8 2	2.54
Do	6264	179	do	do	10 mos.	79	8 2	3.82
Do	6265	180	do	do	3 5/12 mos.	89	9 2	3.5
James W. Scott, Bogamildi.	6266	181	Collaroy ram	do	1½ yrs.	96	14 4	3
Do	6267	182	Pure Merino.	.....	3 yrs.	104	11 12	3
Do	6268	183	do	Ewe	1½ yrs.	96	13 6	2.75
Do	6269	184	do	Ram	1½ yrs.	148	15 8	2.50
Alexander Sloane, Mulwala Station.	6270	185	do	Ewe	2½ yrs.	87	13 14	2.64
Do	6271	186	do	do	3 1/12 yrs.	96	10 9	3.16
Do	6272	187	do	do	2 yrs.	80	.....	.....
Do	6272	187	do	do	2 yrs.	80	11 12	1.2
Do	.....	188	do	do	1½ yrs.	67	8 7	2.91
John L. Suchling, Barsham.	.....	189	do	do	7 yrs.	106	10 5	3.26
Do	5711	190	do	Ram	4 yrs.	99	11 3	1.27
Do	5712	191	do	Ewe	3 yrs.	98	9 4	2.92
Traill Bros., Llangollen	5713	192	do	do	1½ yrs.	62	8 1	4.84
Do	5714	193	do	do	2½ yrs.	70	9 3	2.84
W. Viver's estate, Kings Plains.	5715	194	do	do	1½ yrs.	68	6 14	3.08
Do	5716	195	do	do	2½ yrs.	79	8 0	3.17
Henry Walker, Tong Bong.	5717	196	do	do	5 yrs.	97	8 13	2.85
Do	5718	197	do	Ram	4 yrs.	131	12 14	2.12
Do	5719	198	do	do	5 yrs.	137	18 3	4.78
Do	5720	199	do	do	5 yrs.	131	15 3	3.29
Wilson Sons & Co., Lake Cowal Station.	5721	200	do	Ewe	3 yrs.	62	10 10	3
Do	5722	201	do	do	18 mos.	57	7 12	3

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.					
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.	$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2} =$ R.	$E = \frac{R}{P}$.	Remarks.
1.756	.691	$\frac{1}{1448}$	4.473	68.013	6.490	32.45	23.21	26,268	80,957	Washed.
2.008	.822	$\frac{1}{1218}$	4.473	68.958	6.490	32.45	17.749	20,089	61,908	
1.646	.648	$\frac{1}{1543}$	3.916	61.33	7.258	36.298	23.120	26,174	72,125	
1.720	.677	$\frac{1}{1478}$	4.963	77.89	6.192	30.95	26.951	30,501	98,533	
2.0905	.823	$\frac{1}{1215}$	3.941	61.81	7.308	36.54	14.428	16,330	44,692	
2.274	.895	$\frac{1}{1118}$	5.782	89.22	5.724	28.62	17.890	20,248	70,749	
2.038	.802	$\frac{1}{1248}$	5.758	88.85	5.866	29.33	22.181	25,102	85,594	
1.603	.631	$\frac{1}{1585}$	3.066	47.315	6.133	30.66	21.448	24,841	79,175	
1.806	.711	$\frac{1}{1408}$	5.133	79.214	5.933	29.66	25.122	28,498	96,085	
1.745	.687	$\frac{1}{1458}$	6.166	105.15	7.674	38.37	32.398	36,689	95,569	
1.981	.778	$\frac{1}{1285}$	4.366	67.37	6.858	34.29	17.800	20,146	58,754	
1.941	.764	$\frac{1}{1309}$	4.216	65.06	6.966	34.83	18.096	20,481	58,803	
2.045	.805	$\frac{1}{1241}$	5.525	85.26	6.250	31.25	13.486	15,263	48,844	
1.879	.740	$\frac{1}{1351}$	7.583	117.02	6.188	30.94	37.992	43,001	138,983	
2.223	.875	$\frac{1}{1143}$	6.266	96.69	6.200	31	20.28	22,962	74,070	
2.149	.846	$\frac{1}{1181}$	5.058	78.057	6.300	31.50	17.93	20,295	64,430	
1.951	.768	$\frac{1}{1302}$	5.075	78.319	6.400	32	21.829	24,144	75,451	
1.529	.602	$\frac{1}{1661}$	3.900	71.186	5.300	26.50	26.691	30,208	112,980	
1.890	.744	$\frac{1}{1343}$	5.033	77.652	5.475	27.38	22.543	25,515	93,205	
1.854	.730	$\frac{1}{1369}$	3.833	59.877	5.533	27.66	22.754	20,461	73,976	
1.8925	.745	$\frac{1}{1342}$	3.933	61.700	6.525	32.63	17.574	19,890	60,967	
1.9305	.760	$\frac{1}{1316}$	5.3416	82.437	7.983	39.92	22.982	25,955	65,026	
2.200	.866	$\frac{1}{1154}$	4.8333	74.589	7.150	35.75	15.970	18,080	50,580	
2.129	.838	$\frac{1}{1193}$	3.900	61.186	5.142	25.71	13.767	15,581	60,604	
1.908	.755	$\frac{1}{1324}$	4.650	71.760	7.992	39.96	21.400	24,220	60,610	
1.887	.743	$\frac{1}{1343}$	5.716	88.209	7.266	36.33	25.68	29,070	80,016	
2.294	.903	$\frac{1}{1107}$	6.258	96.575	5.850	29.25	19.92	22,550	77,100	
2.1235	.836	$\frac{1}{1197}$	5.466	84.35	7.192	35.96	19.394	21,951	61,045	
2.081	.819	$\frac{1}{1220}$	4.516	69.69	5.132	25.66	16.68	18,885	73,592	
2.449	.964	$\frac{1}{1057}$	7.250	111.88	6.858	34.29	19.341	21,890	63,839	
2.068	.814	$\frac{1}{1228}$	5.283	81.529	6.740	33.70	19.764	22,370	66,381	
2.347	.924	$\frac{1}{1082}$	5.250	81.019	3.450	17.25	15.967	18,072	104,740	
1.763	.694	$\frac{1}{1440}$	6.907	107.69	6.600	33	35.52	40,200	121,820	
1.951	.768	$\frac{1}{1302}$	3.982	72.46	7.342	36.71	16.742	18,949	51,632	
1.8645	.734	$\frac{1}{1362}$	4.091	63.233	7.600	38	18.828	21,310	56,080	
2.175	.856	$\frac{1}{1167}$	4.358	67.177	7.790	38.95	14.722	16,663	42,781	
1.9585	.769	$\frac{1}{1299}$	4.953	77.536	6.816	34.08	20.727	23,515	69,001	
1.527	.601	$\frac{1}{1663}$	3.908	61.309	4.690	23.45	26.214	29,660	123,260	Do.
1.763	.694	$\frac{1}{1440}$	4.958	77.513	6.550	32.75	26.11	28,885	88,202	Unwashed.
1.9355	.762	$\frac{1}{1312}$	5.800	78.352	6.432	32.16	24.784	28,051	88,398	
2.195	.864	$\frac{1}{1157}$	5.483	84.615	6.324	31.62	18.250	20,607	65,174	
2.083	.820	$\frac{1}{1218}$	7.916	59.229	7.190	35.95	29.19	33,038	171,352	
2.355	.927	$\frac{1}{1078}$	6.000	92.59	6.090	30.45	17.301	19,546	64,190	
1.8365	.723	$\frac{1}{1383}$	4.441	68.53	7.225	36.25	21.075	23,857	66,051	
2.129	.838	$\frac{1}{1193}$	5.100	78.704	8.533	42.66	18	20,386	47,768	
1.788	.704	$\frac{1}{1420}$	4.908	76.941	7.416	37.08	24.563	27,801	74,976	
1.834	.722	$\frac{1}{1384}$	4.016	61.97	4.232	21.16	19.54	22,125	104,560	
1.931	.760	$\frac{1}{1316}$	4.541	70.078	6.666	33.33	19.48	22,038	52,522	
1.722	.678	$\frac{1}{1474}$	3.825	59.028	5.266	26.33	20.638	23,359	88,716	
1.712	.674	$\frac{1}{1483}$	3.716	57.346	7.450	37.25	20.28	22,436	60,233	
1.682	.662	$\frac{1}{1509}$	4.075	62.885	7.124	35.62	23.04	26,083	137,640	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.		Corrected length of fiber in crimp.
NEW SOUTH WALES—c't'd.									
						Pounds.	*Lbs.*	*oz.*	*Inches.*
Edmund J. Allen, Stony Creek.	5951	202	Pure Merino..	Ewe	5 yrs	76	7	7	3
Do	5952	203	.....do	....do ...	5 yrs	82	8	4	3. 22
Do	5953	204	.....do	....do ...	7 yrs	76	11	2	2. 92
William D. Crozier, Horse Shoe.	5954	205	.....do	....do ...	2 yrs	76	7	3	3. 69
Do	5955	206	.....do	....do ...	5¼ yrs ...	76	7	4	3. 23
Do	5956	207	.....do	....do ...	16 mos ..	60	7	1	3. 46
Do	5957	208	.....do	....do ...	16 mos ..	64	7	9	2. 54
William D. Crozier, Moorna.	5958	209	.....do	....do ...	1 7/12 yrs ..	65	10	7	4. 15
Do	5959	210	.....do	....do ...	3 yrs	100	13	4	3. 45
Do	5960	211	.....do	Ram....	3 yrs	136	17	12	2. 77
Devlin & Co., Ganmain..	5961	212	Australian Merino.	Ewe	16 mos ..	50	8	4	3. 38
Do	5962	213	.....do	Ram....	16 mos ..	.....	12	8	2. 96
Do	5962	213	.....do	....do ...	16 mos ..	.....	.....	.....	.....
Vincent J. Dowling, Lue.	5963	214	Lue Merino ..	....do ...	14 mos ..	82½	10	14	2. 25
Do	5964	215	.....do	Ewe	13 mos ..	60½	13	0	3
Do	5965	216	.....do	Ram....	16 mos ..	104½	15	2	2. 75
Do	5966	217	.....do	....do ...	2½ yrs ...	128½	18	0	2. 50
Do	5967	218	.....do	....do ...	2½ yrs ...	117½	17	2	2. 75
Do	5968	219	.....do	Ewe	2½ yrs ...	94½	12	15	3. 75
Do	5969	220	.....do	....do ...	2½ yrs ...	91	11	12	3
Do	5970	221	.....do	Ram....	5 yrs	128½	22	15	2
Do	5970	221	.....do	....de ...	5 yrs	.....	.....	.....	.....
Dulhunty & Deakin, Killoola.	5971	222	Pure Merino..	....do ...	27 mos ..	105	14	5	3. 75
Do	5972	223	.....do	....do ...	2 yrs	102	12	0	2. 75
Duntoon estate, Queanbeyan.	5973	224	Seven-eighths Vermont Merino.	....do ...	5 mos ...	127	18	12	2. 01
Charles C. Hall, Yeumburra.	5974	225	Pure Merino..	...do	18 mos ..	100	11	6	2. 5
William Harkness, Lincluden.	5975	226	.....do	Ewe	425 dys..	70	6	5	1. 76
Do	5976	225	.....do	...do	425 dys..	62	7	12	2. 73
Horsfall & Co., Kearbury.	5977	128	.....do	...do	4 yrs	.....	7	8	3. 5
Do	5978	229	.....do	...do	4 yrs	.....	10	9	2. 75
C. H. James and J. Gray, Kentucky, Corowa.	5979	230	.....do	...do	17 mos..	49	7	13	2. 88
G. Merriman, Yass.....	5980	231	.....do	Wether.	3 yrs	150	12	5	3. 26
G. J. Mulholland, Oura ..	5981	232	One-half Vermont Merino.	Ewe	3 yrs	74	7	6	2. 08
Andrew Murray, Bannockburn.	.....	233	American Merino.	...do	1⅝ yrs ...	75	10	1	6. 08
Do	.....	234	American-Spanish Merino	Ram....	5 yrs	133	16	9	2. 92
Do	.....	234	.....do	...do	5 yrs	133	.....	.....	.....
James W. Scott, Bogamilde Station.	6132	235	Collaroyan ...	...do	2¼ yrs ...	147	20	4	2. 5
Do	6132	235	.....do	...do	2¼ yrs ...	147	.....	.....	.....
Do	6133	236	.....do	...do	22 mos ..	136	17	10	2. 75
Do	6134	237	Pure Merino..	Ewe	1½ yrs ...	86	12	0	3. 25
Tubbo Estate Co., Tubbo.	6135	238	Tasmanian Merino.	...do	17½ mos.	67	9	12	3
James E. Warby, Billenbah.	6136	239	Pure Merino..	...do	17 mos ..	63	7	13	2. 75
Peter C. Watt, Goonal ...	6137	240	.....do	...do	15 mos ..	68	8	10	2. 75
Do	6138	241	.....do	...do	15 mos ..	77	8	10	3. 94
Do	6139	242	.....do	...do	15 mos ..	65	8	12	2. 5
Do	6140	243	.....do	...do	15 mos ..	75	8	5	3. 08
Duntoon estate, Queanbeyan.	6141	244	Leicester.....	Ram....	4 yrs	94½	10	11	2. 75
Do	6142	245	.....do	Ewe	4 yrs	59¼	7	8	.....
Do	6143	246	.....do	Ram....	2 yrs	324	9	10	8
Do	6144	247	.....do	Ewe	2 yrs	224½	10	6	7. 25
Do	6145	248	.....do	Ram....	16 mos ..	178	14	2	8. 09

of tests of individnal samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2 R.} =$	$E = \frac{R}{P'}$	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
1.570	.618	1/1617	4.458	68.797	4.408	22.04	28.937	32,751	148,600	
2.144	.844	1/1184	6.083	93.874	4.932	24.66	21.666	28,964	97,178	
2.220	.874	1/1144	5.841	90.140	7.182	35.91	18.96	21,465	59,769	
1.652	.650	1/1537	5.541	85.510	4.400	22	32.48	36,768	167,150	
1.913	.753	1/1327	3.900	61.186	6.041	30.20	17.051	19,299	63,892	
1.867	.735	1/1360	6.350	97.995	5.958	29.79	29.147	32,989	110,730	
1.722	.678	1/1474	5.233	80.757	7.016	35.08	28.236	31,957	91,100	
2.121	.835	1/1197	6.058	93.489	6.550	32.75	21.546	24,386	74,461	
2.434	.958	1/1043	6.800	104.939	5.978	29.89	18.364	20,785	69,540	
1.887	.743	1/1345	4.808	74.198	5.524	27.62	21.599	24,445	88,519	
1.692	.666	1/1500	5.058	78.056	5.600	28	28.268	31,996	114,272	
1.788	.704	1/1420	4.925	77.004	6.740	33.70	24.64	27,897	82,781	Unwashed.
1.845	.726	1/1378	3.916	61.433	6.050	30.25	18.406	20,832	68,868	Washed.
2.1096	.795	1/1257	5.283	81.529	5.324	26.62	20.736	23,469	88,165	
1.804	.710	1/1407	5.658	87.316	5.066	25.33	27.816	30,901	124,230	
2.020	.795	1/1257	5.191	80.209	5.236	26.18	20.261	23,037	87,998	
2.342	.922	1/1084	5.033	77.671	4.516	22.58	14.681	16,616	73,590	
2.210	.870	1/1149	5.583	86.158	6.708	33.54	18.289	20,700	61,718	
2.237	.881	1/1131	5.858	90.412	6.408	32.04	18.73	21,198	66,163	
1.788	.704	1/1420	5.916	92.297	8.140	40.70	29.608	33,511	82,336	
2.218	.873	1/1145	6.108	95.371	7.870	39.35	19.865	22,483	57,138	Unwashed.
2.322	.914	1/1093	6.100	93.137	6.682	33.41	17.699	20,491	61,323	Washed.
1.994	.785	1/1273	5.275	81.345	6.960	34.75	21.226	24,025	69,137	
1.745	.687	1/1455	3.958	62.081	6.566	32.83	20.323	23,002	70,066	
2.101	.827	1/1208	4.850	74.846	6.990	34.95	17.579	19,896	56,929	
1.834	.722	1/1385	4.966	77.637	5.784	28.92	23.62	26,735	92,450	
1.060	.807	1/1238	4.466	68.920	5.416	27.08	17,003	19,244	71,065	
1.771	.697	1/1434	4.600	71.088	5.500	27.50	23.466	26,559	96,578	
1.412	.556	1/1797	3.983	62.467	6.682	33.41	31.963	36,177	108,270	
1.694	.667	1/1498	3.566	55.021	6.266	31.33	19.791	22,400	71,497	
1.532	.603	1/1657	5.500	84.877	6.924	34.62	37.494	42,436	122,570	
2.0245	.797	1/1254	4.383	67.639	5.940	29.70	17.118	18,933	63,751	
1.961	.772	1/1295	5.308	81.914	6.782	33.91	22.084	24,995	73,712	
2.167	.853	1/1171	5.041	77.794	7.158	35.79	17.176	19,439	54,316	
2.314	.911	1/1097	4.500	69.445	5.824	29.12	13.445	15,218	52,262	Unwashed.
2.419	.952	1/1049	4.833	74.584	6.650	33.25	13.214	14,956	44,982	Washed.
2.484	.977	1/1022	5.208	80.371	5.774	28.87	16.616	18,806	51,652	Unwashed.
2.484	.978	1/1022	6.408	98.890	7.282	36.41	13.504	15,284	52,940	Washed.
2.347	.924	1/1083	6.225	96.066	5.682	28.41	18.08	20,462	72,030	
2.125	.871	1/1148	4.450	68.673	7.190	35.95	15.767	17,845	49,640	
2.063	.812	1/1231	4.266	65.834	5.266	26.33	16.037	18,154	68,939	
1.600	.630	1/1587	6.658	102.748	7.066	35.33	41.612	47,097	133,307	
2.005	.789	1/1268	4.900	76.618	7.024	35.12	19.502	22,073	62,850	
2.058	.810	1/1234	4.600	70.988	5.532	27.66	17.377	19,667	71,106	
1.893	.745	1/1341	4.766	73.550	6.132	30.66	21.28	24,080	78,550	
1.883	.741	1/1349	5.190	80.193	7.240	36.20	23.46	26,560	73,370	
3.336	1.313	1/761	13.56	209.26	6.432	32.16	19.495	22,064	68,610	
3.419	1.346	1/742	18.33	282.87	4.008	20.04	25.088	25,396	141,680	
3.701	1.457	1/686	23.64	364.82	7.616	38.08	27.614	31,253	82,074	
3.531	1.390	1/719	28.016	432.35	8.850	44.25	35.962	40,691	91,957	
3.950	1.555	1/643	28.291	436.696	8.458	42.29	29.655	33,565	79,370	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
NEW SOUTH WALES—c't'd.						*Pounds.*	*Lbs. oz.*	*Inches.*
Duntoon estate, Queanbeyan.	6146	249	Leicester	Ewe	15 mos.	168	13 0	8.11
Do	6147	250	Pure Lincoln.	Ram	13 mos.	109	20 5	14.04
Do	6147	250	do	do	13 mos.	109	20 5	
Do	6148	251	do	Ewe	13 mos.	96½	14 15	9.12
Andrew Murray, Bannockburn.	6149	252	do	do	1 yr.	98	11 2	9
Do	6150	253	do	Ram	58 wks.	128	14 5	9.83
Duntoon estate, Queanbeyan.	6151	254	Lincoln Merino.	Wether.	2 yrs.	164	14 4	4.23
Do	6152	255	do	Ewe	2 yrs.	165	11 8	3.41
Do	6153	256	do	Wether.	16 mos.	138½	14 2	3.17
Do	6154	257	do	Ewe	15 mos.	110	11 12	5.16
Do	6166	258	do	do	21 mos.		7 10	5
Tubbo Estate Co., Wagga Wagga.	6191	277	Australian Merino.	do	2½ yrs.	85	13 11	2.50
Do	6192	278	do	do	2½ yrs.	87	8 14	3.25
Do	6193	279a	do	do	2½ yrs.	91	9 10	2
Do	6194	279b	do	do	2½ yrs.	91	9 10	2
Do	6195	279c	do	do	2½ yrs.	91	9 10	2
Do	6196	279d	do	do	2½ yrs.	91	9 10	
Estate of W. Vivere, Kings Plains.	6168	280	Pure Merino	do	1 yr.	53	6 4	2.50
Do	6169	281	do	do	1½ yrs.	67	6 1	2.57
Do	6170	282	do	do	1½ yrs.	67	6 1	2.82
Do	6171	283	do	do	2½ yrs.	78	6 5	2.90
Baled wool (name of breeder, etc., not given).		5E						2.50
Do		7E						2.25
Do		9F						2.50
Do		119c						
Do		21b						3.25
Do		25b						2.50
Do		31b						3.25
Do		41a						3
Do		44a						2.50
Do		46						2
Do		65b						2.50
Do		73						2.75
Do		82b						3.75
Do		95c						2.50
Do		97c						2
Do		103d						2.25
Do		117b						2.75
Do		125b						2.75
Do		127b						2.75
Do		130c						2.25
Do		131c						
Do		141b						
Do		168						
NEW ZEALAND.								
John Anderson, Kerem		[a]1						3
Do		2	Merino					4
L. M. Williams, Bartings		1						5.25
Do		2	Cross					6
Green Hill Station, Green Hill.		1c						6
Archibald McLean, Green Hill.		1						4
Chas. Goulter, Hawkesbury, Blenheim.		1	Merino					2.50
Do		1	do					2.50
Do		1	do	[b]Stud ram	5 yrs.	148	15 0	
Do		2		Ram	5 yrs.	144	13 0	
Do		3	Merino	Ewe	5 yrs.		11 12	
Do		4	do	do	14 mos.		10 0	
Do		6	do	do	14 mos.			
J. G. Ward, Invercargil		1f	do					3.50

[a] Bales. [b] Challenge.

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} =$	$18109 \frac{S}{D^2} = \frac{S}{R}$.	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
3.770	1.484	3/2	24.55	378.864	7.774	38.87	27.63	31,280	80,470	
3.584	1.411	7/5	25.43	392.44	8.724	43.62	31.67	35,850	82,190	Unwashed.
3.904	1.537	5/3	25.20	388.794	7.840	39.20	26.45	29,940	76,390	Washed.
2.985	1.775	9/5	19.541	311.563	9.040	45.20	35.067	39,712	87,860	
2.617	1.302	9/7	22.208	342.72	8.958	44.79	51.866	58,704	131,060	
2.588	1.007	5/4	19	30.321	9.216	46.58	45.388	51,371	110,283	
3.112	1.225	5/4	14.616	225.559	7.416	37.08	23.597	26,708	72,024	
2.972	1.170	3/2	9.425	155.44	5.074	25.37	17.072	19,323	76,165	
3.226	1.270	7/5	14.68	216.54	5.900	29.50	22.569	25,544	86,590	
2.131	.839	1/1	16.758	258.615	7.658	39.29	59.04	66,826	174,530	
3.170	1.248	5/4	18.66	287.967	7.008	35.04	29.71	33,620	95,970	
1.893	.745	1/1	4.108	633.960	5.474	27.37	18.34	20,760	75,850	Scoured.
1.684	.663	1/1	4.175	64.500	7.600	38	23.555	26,660	70,158	
1.735	.683	1/1	4.963	77.899	6.974	34.87	26.48	29,970	85,970	
2.3725	.934	1/1	5.283	81.529	6.582	32.91	15.02	17,000	51,670	
1.821	.717	1/1	8.891	137.209	6.216	31.08	42.899	48,553	156,222	
1.844	.726	1/1	4.691	72.493	6.640	33.20	22.073	24,974	75,247	Do.
1.778	.700	1/1	4.325	66.744	6.908	34.54	21.889	24,775	71,728	
1.5545	.612	1/1	3.841	59.275	6.132	30.66	25.448	28,802	93,942	
2.068	.814	1/1	3.891	47.682	7.258	36.29	14.557	16,476	45,401	
2.119	.834	1/1	6.708	103.520	5.316	26.58	23.902	27,115	101,780	
2.124	.836	1/1	7.600	117.28	7.374	36.87	26.95	30,500	82,740	
1.860	.732	1/1	5.208	80.371	6.450	32.25	24.08	27,260	84,580	
1.367	.538	1/1	4.691	72.513	5.816	29.08	31.90	36,108	124,100	
1.545	.608	1/1	3.516	54.260	6.416	32.08	23.56	26,670	83,140	
1.580	.622	1/1	3.608	55.679	5.032	25.16	23.12	26,170	104,050	
1.878	.739	1/1	4.433	68.416	6.240	31.20	19.65	22,240	71,290	
1.852	.729	1/1	5.350	82.563	5.932	29.66	24.95	28,240	95,230	
1.664	.655	1/1	4.991	78.132	6.100	30.50	28.84	32,640	10,700	
2.172	.855	1/1	5.525	85.263	6.350	31.75	18.73	21,200	66,790	
2.088	.822	1/1	6.350	97.995	5.716	28.58	23.304	26,375	92,288	
2.132	.839	1/1	5.040	77.779	8.050	40.25	17.74	20,074	49,886	
1.898	.747	1/1	4.916	74.322	8.400	42.00	21.834	24,712	58,839	
1.563	.615	1/1	3.783	58.380	6.682	33.41	24.776	28,042	83,933	
1.728	.680	1/1	4.300	66.359	7.400	37	23.04	26,078	70,481	
1.972	.776	1/1	5.050	77.933	5.916	29.58	20.777	23,516	79,501	
1.888	.743	1/1	4.725	72.917	8.750	43.75	21.20	24,005	54,865	
1.687	.664	1/1	3.991	62.690	7.166	35.83	22.38	25,330	70,710	
2.154	.848	1/1	6.175	94.322	7.240	36.20	21.29	24,100	66,570	
1.933	.761	1/1	4.950	77.390	6.682	33.41	21.19	23,990	71,800	
1.733	.682	1/1	3.216	49.630	7.758	38.79	17.13	19,390	49,990	
1.850	.728	1/1	5.233	80.757	7.980	39.90	24.46	27,682	69,390	
1.814	.714	1/1	6.450	99.538	8.590	42.95	31.50	35,652	83,010	
1.756	.691	1/1	3.783	58.380	7.432	37.16	19.628	22,216	59,786	
2.198	.865	1/1	5.716	26.481	7.390	36.95	18.93	21,425	57,986	
1.870	.736	1/1	3.158	48.735	5.490	27.45	14.44	16,353	59,570	
3.224	1.269	7/5	15.12	233.33	5.532	27.66	23.274	26,342	95,342	
2.980	1.173	3/2	18.07	278.86	8.640	43.20	32.557	36,848	85,295	
2.713	1.068	9/8	10.41	160.65	5.924	29.62	22.629	25,612	86,469	
2.665	1.049	5/4	8.291	128.04	4.750	23.75	18.678	21,140	89,010	
2.528	.995	1/1	5.033	77.675	7.350	36.75	12.60	14,261	38,806	
2.030	.799	1/1	4.916	76.865	4.300	21.50	19.087	21,602	10,040	
1.735	.683	1/1	5.175	79.852	5.300	26.50	27.50	31,130	117,400	
2.256	.888	1/1	5.900	92.050	6.590	32.95	18.547	20,992	63,710	

Details of history and average results

FOREIGN—Continued.

Name and address	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
NEW ZEALAND—cont'd.								
						Pounds.	*Lbs. oz.*	*Inches.*
J. G. Ward, Invercargil		*1	Half cross					6.50
Do		2a	....do					6
Do		*2	Merino					3
Williams & Kettle, Tawroa.		*1h						3.50
Do		*2	Half cross					5.50
Do		3						3
Do		4						4
Wm. Telford, Clifton, Waiwers Otago.		*1	Romney Marsh	Ewe				7.50
Poperangi Station		*1	Merino					2.50
Do		*2	....do					3
Do		*3a	....do					3.25
Do		*4						2.50
F. M. Chambers, Havelock.		*1						4
Do		2	Half cross					7
Do		3						4
J. C. Jorka, Hawara		11						9
Douglas McLean, Maraeliakaho.	5474	*1e	One-fourth cross Battle Ax.					6.75
Do		1	Merino	Hoggett ram.				3.50
Do		2	Three-fourths Battle Ax.					7.50
Do		2	Cross					3.75
Do		2	Merino	Hoggett ram.				3
Do		2	Half cross					5.50
Do		3	Three-fourths cross.					6
Do		4	Merino	Hoggett ram.				
Do		5	....do	....do				
Do		6	....do	Ewe				
Do		8	....do	Hoggett ram.				3
Do		9	....do	Ewe				
Do		10	....do	....do				4
Do		11	....do	....do				1.75
Do		12	....do	....do				3
Do		13	....do	....do				3.25
Do		14	....do	....do				2.50
Do		15	....do	Ram				4
Do		16	....do	....do				2.50
Do		17	....do	....do				3.50
John Harding, Warpukwan.		1k	Romney Marsh					5
Bernard H. Ward, Marlborough.		1	Merino-Tasmanian.	Ram	5 yrs	126	12 0	3.50
Do	5473	2	....do	Stud ram	3 yrs	112	11 3	2
Do		3	....do	Ewe	13½ mos.	52	8 0	12.50
Do		4	....do	....do		48	7 0	3
Russell Brothers		8	Merino	Ram				
Wm. Telford, Clifton, Waiwersstago.		*N	Romney Marsh	....do	16 mos.			12.50
Do			....do	....do				
Trimley		*1	....do					7
Chas. Goulter, Hawkesbury.	5472	*1	Merino					
Do		70						
L. M. Williams		1	Cross					
ORANGE FREE STATE.								
N. Joubert, Bethulie		7	Merino		11 mos.			2.72
Do		9	....do		11 mos.			1.90
Do		12	....do		11 mos.			2.99
Do		13	....do		11 mos.			3.26
Do		14b	....do		11 mos.			2.72

*Bales.

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2} = \frac{S}{R}$	$E = \frac{R}{P}$.	Remarks.
Centimillimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.			
1.936	.762	1/33	5.250	81.019	7.340	36.70	22.41	25,360	69,110
2.593	1.020	1/25	10.65	164.35	6.940	34.70	25.34	28,685	82,660
2.022	.796	1/32	4.741	73.164	6.832	34.16	18.553	20,998	61,473
3.189	1.255	1/20	14.09	217.54	7.032	35.16	22.168	25,090	71,360
2.756	1.085	1/23	11.31	174.53	6.090	30.45	23.824	26,964	88,554
2.749	1.082	1/23	12.02	185.49	7.358	36.79	25.44	28,800	78,290
2.174	.855	1/30	16.92	262.115	6.000	30	57.28	64,830	216,580
2.977	1.172	1/23	18.09	279.27	7.540	37.70	32.65	36,963	98,040
2.477	.975	1/26	6.825	105.30	3.866	19.33	17.798	20,144	104,210
2.246	.884	1/29	5.291	81.725	5.682	28.41	16.02	18,135	63,840
2.226	.876	1/29	4.966	77.63	6.140	30.70	16.085	18,148	59,117
2.180	.858	1/29	5.666	87.439	4.750	23.75	18.988	21,491	90,490
2.228	.877	1/29	13.61	210.03	7.932	39.66	43.867	49,650	125,180
2.845	1.120	1/23	15.450	238.42	8.324	41.62	30.541	34,566	83,052
3.506	1.380	1/19	22.08	340.74	8.008	40.04	28.74	32,520	81,240
2.997	1.172	1/23	18.75	289.35	8.150	40.75	33.40	37,802	92,767
1.537	.605	1/42	4.0163	61.980	7.032	35.16	27.199	30,785	87,522
3.861	1.520	1/17	28.90	448.99	8.008	40.04	31.018	35,107	87,679
3.069	1.208	1/21	11.99	186.13	6.690	33.45	20.367	23,054	68,916
1.948	.767	1/33	.....	.....	.....	.....	.....	.....	.....
2.850	1.122	1/23	7.650	118.05	7.466	37.33	15.065	17,055	45,688
2.159	.849	1/30	4.658	71.883	6.356	31.78	15.988	18,096	56,943
2.281	.898	1/28	5.108	78.828	4.524	22.62	15.707	17,778	78,596
2.0915	.795	1/32	6.308	97.347	6.408	32.04	23.07	26,113	81,500
2.050	.807	1/31	8.033	123.968	7.024	35.12	62.69	70,960	202,000
1.915	.754	1/34	5.283	81.529	5.050	25.25	23.08	26,068	103,310
1.730	.681	1/37	3.641	56.189	6.766	33.83	19.464	22,030	65,121
1.812	.713	1/35	4.266	65.834	3.400	17	20.78	23,525	141,650
1.756	.691	1/36	5.375	82.948	7.000	35	27.89	31,565	110,485
1.908	.751	1/33	4.375	69.516	6.340	32.70	19.23	21,750	66,550
2.129	.838	1/30	5.033	77.671	7.258	36.29	17.766	20,109	55,408
2.075	.817	1/31	5.058	78.056	7.600	38	18.796	21,768	55,982
2.058	.810	1/31	5.158	79.600	5.540	27.70	19.041	22,053	79,616
3.460	1.362	1/18	22.53	347.69	7.050	35.25	30.11	34,080	96,680
2.311	.909	1/28	4.333	66.868	6.890	34.45	12.98	14,691	42,647
1.7045	.671	1/37	4.125	63.658	6.866	34.33	22.716	25,711	74,894
3.836	1.510	1/17	25.94	401.31	7.808	39.04	28.17	31,888	81,680
1.588	.625	1/40	5.333	82.300	6.832	34.16	34.58	38,248	119,700
3.836	1.510	1/17	25.94	401.31	7.808	39.04	28.17	31,888	81,680
3.663	1.442	1/17	22.67	349.83	7.832	39.16	27.08	30,590	78,130
1.992	.784	1/32	4.333	66.86	5.216	26.08	17.47	19,775	75,820
1.611	.634	1/39	4.533	69.954	6.458	32.29	27.945	31,629	97,958
2.096	.825	1/31	3.658	56.451	5.666	28.33	13.321	15,012	53,224
1.949	.767	1/33	4.000	61.729	5.458	27.29	17.641	19,069	69,873
1.895	.746	1/34	4.566	70.464	6.282	31.41	20.34	23,025	73,300
2.365	.931	1/27	5.850	80.279	7.558	37.79	16.734	18,940	50,120

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
ORANGE FREE STATE—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
N. Joubert, Bethulie		15	Merino		11 mos			2.45
Do		16	do		11 mos			3.26
Do		17a	do		11 mos			2.17
Do		18	do		11 mos			3.81
Do		19	do		11 mos			2.99
RUSSIA.								
Unknown		1	Lushrirsk	Lamb				3
Do		1	Karakulskaic	do				6.50
Do		2a	Tshushka	do				4
Do		2b	do	do				9.50
Do		2						
Do		2						
Do		3	Lushrirsk	Lamb				3.50
Do		3						
Do		4	Pumaia	Lamb				5.50
Do		4	do	do				5.50
Do		4	Lushursh	do				3
Do		5						4.50
Do		5						6.50
Do		6	Zigaia	Lamb				5
Do		7		do				3
Do		8		do				4
Do		8		do				
Do		9	Bastard between Merino and Angora goat.	do				3.50
Do		9	Lushrirsk	Ewe				2.25
Do		9						
Do		10	Tushunskaia	Lamb				4
Do		10	Lushrirsk	Ewe				3
Do		11	Tushunskaia and Oxfordshire Down.	Lamb				6.50
Do		11	Lushrirsk					6
Do		12	Romanowkaia.	Lamb				4
Do		12	do	do				5.50
Do		13	Lushrirsk	Ewe				4.50
Do		14	do	do				6.50
Do		14	do					
Do		15	do					4.50
Do		15	do					
Do		16	do					
Do		16	Merino					
Do		17	Camel's hair					3
Do		17	do					6
Do		17	Masaeu Merino.					
Do		17	Camel's hair					
Do		18	do					2
Do		19	do					2.25
Do		20	Dervisher Dycbaga and Ordyn.	Lamb				5
Do		20						
Do		*21,22						6
Do		*21,22						6
Do		*23						
Do		*23						
Do		24	Infantado	Ewe	3 yrs			2.50
Do	19314	24		do	3 yrs		14 12	2
Do		25		do	2 yrs		12 7	2.50
Do		26	Infantado	do	2 yrs		10 2	2
Do		27	do	do	2 yrs		18 8	2
Do		28	do	Ram	2 yrs		19 4	2
Do		29	do	Ewe	2 yrs		12 14	2
Do		30	do	do	2 yrs		14 0	2.50

* Bales.

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2 S'} = \frac{S}{R}$	$18109 \frac{S}{D^2} = \frac{R}{P}$	$E = \frac{R}{p}$	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
1.631	.462	1/2 1/4	4.766	73.55	6.690	33.45	28.665	32,444	96,993	
1.410	.555	1/1 1/8	4.583	70.72	6.350	31.75	36.883	41,745	131,470	
1.789	.704	1/1 1/16	4.033	62.23	5.174	25.87	20.16	22,815	88,205	
1.720	.677	1/1 1/16	3.991	62.690	5.208	26.04	27.173	240,430	93,816	
1.921	.756	1/1 3/16	7.883	121.65	4.774	23.87	34.178	38,684	162,050	
2.655	1.045	1/1 1/16	33.03	509.730	9.500	47.50	74.97	84,850	178,650	Black.
3.178	1.251	1/1 1/16	26.516	409.204	7.724	38.62	41.997	47,533	123,070	White.
2.891	1.138	1/1 1/16	33.76	52.099	7.750	38.75	64.629	73,147	188,760	Coarse.
2.784	1.096	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	Fine.
7.346	2.892	1/1 1/16	42.516	656.121	9.432	47.16	15.866	17,958	38,080	Black.
3.132	1.233	1/1 1/16	22.333	344.650	8.900	44.50	36.422	41,222	92,635	White.
4.082	1.607	1/1 1/16	22.616	349.017	4.232	21.60	23.263	24,686	116,380	Black.
3.463	1.363	1/1 1/16	37.775	582.87	9.616	48.08	50.365	57,004	118,830	White.
2.386	.939	1/1 1/16	21.683	334.619	8.000	40.00	60.93	68,965	172,400	Fine.
4.933	1.942	1/1 1/16	44.90	693.912	9.740	48.70	29.52	33,415	68,898	Coarse.
2.828	1.113	1/1 1/16	25.475	393.183	3.624	28.12	50.955	57,672	205,090	Black.
2.873	1.131	1/1 1/16	35.858	553.36	7.240	36.20	69.49	78,650	217,200	Fine.
5.815	2.289	1/1 1/16	35.800	552.47	8.532	42.66	16.93	19,170	44,940	Coarse.
4.131	1.626	1/1 1/16	42.016	649.100	7.208	36.04	39.387	44,576	123,680	
2.322	.914	1/1 1/16	9.158	151.329	6.200	31.00	27.17	30,755	99,225	
2.279	.897	1/1 1/16	8.685	134.029	5.458	27.29	26.67	30,185	110,610	
3.358	1.322	1/1 1/16	52.986	818.698	7.174	35.87	75.17	85,083	188,420	
1.761	.693	1/1 1/16	12.70	196.990	6.624	33.12	65.52	74,161	223,900	
3.343	1.316	1/1 1/16	8.725	134.64	5.300	26.50	12.49	14,135	58,350	Fine.
4.585	1.805	1/1 1/16	43.125	665.51	3.408	17.04	32.82	37,142	218,000	Coarse.
3.686	1.451	1/1 1/16	53.967	833.84	8.600	43	63.54	71,921	167,250	
3.531	1.390	1/1 1/16	45.85	707.57	5.250	26.25	58.83	66,593	259,600	
2.482	.977	1/1 1/16	20.86	321.91	7.824	39.12	54.17	61,321	156,780	
5.599	2.204	1/1 1/16	28.15	434.42	8.150	40.75	34.77	39,350	96,580	
2.258	.887	1/1 1/16	18.71	288.73	8.966	44.83	58.97	66,750	148,850	Fine.
5.670	2.232	1/1 1/16	46.32	714.82	8.890	44.45	23.05	26,092	58,700	Coarse.
2.873	1.131	1/1 1/16	23.30	359.57	8.108	40.54	43.22	48,925	120,650	
2.035	.801	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	Fine.
3.275	1.289	1/1 1/16	17.41	268.67	4.058	20.29	25.97	29,395	144,850	
3.010	1.185	1/1 1/16	9.950	164.55	5.124	25.62	17.57	19,883	77,625	Fine.
4.831	1.902	1/1 1/16	53.86	831.18	7.574	27.87	29.33	33,190	119,100	Coarse.
2.960	1.165	1/1 1/16	28.37	437.81	9.190	45.95	51.807	58,636	127,600	
2.314	.911	1/1 1/16	7.975	124.07	7.200	36	14.56	19,890	55,260	
1.319	.519	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	Light.
1.560	.614	1/1 1/16	4.666	72.007	7.200	36	30.677	34,720	96,446	Fine.
2.322	.914	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	
4.740	1.866	1/1 1/16	34.866	537.97	5.666	28.33	24.910	28,194	99,520	Coarse.
1.987	.782	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	Medium.
2.881	1.134	1/1 1/16	.....	.....	.....	.....	.....	.....	.....	Dark.
1.992	.784	1/1 1/16	12.92	200.38	8.990	44.96	52.096	58,963	131,160	Fine.
4.933	1.942	1/1 1/16	37	570.99	7.016	35.08	24.327	27,534	78,309	Coarse.
6.165	2.427	1/1 1/16	36	555.564	8.950	44.75	15.15	17,150	38,330	Do.
2.287	.900	1/1 1/16	6.670	102.93	6.408	32.04	20.40	23,090	72,070	Fine.
5.738	2.250	1/1 1/16	25.03	386.27	8.516	42.58	12.16	13,765	32,332	Coarse.
2.541	1	1/1 1/16	8.210	126.700	7.280	36.40	20.34	23,025	63,258	Fine.
1.979	.779	1/1 1/16	4.950	77.390	7.640	38.20	20.222	22,885	59,913	
1.966	.774	1/1 1/16	5.460	87.038	4.340	21.70	22.601	25,581	117,870	
2,500	.984	1/1 1/16	6.058	93.489	6,458	32.29	15.50	17,555	54,360	
2.129	.838	1/1 1/16	4.708	72.655	6.516	32.58	16.618	18,809	72,682	
2.152	.847	1/1 1/16	9.450	155.88	6.816	34.08	32.64	36,950	108,400	
2.083	.820	1/1 1/16	5.025	77.547	6.100	30.50	18.96	20,970	68,760	
2.106	.829	1/1 1/16	5.916	92.297	7.516	37.58	21.34	24,155	64,275	
2.362	.930	1/1 1/16	10.38	160.187	5.908	29.54	29.74	33,660	113,900	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
RUSSIA—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Unknown		1	Brown goat skin.					
Do		2	Black Persian lamb.					
Do		3	Goat skin					
Do		4	Gray Crimean lamb.					
Do		5	Black Kharshow Saksak lamb.					
From exhibit of Russia cottage industry, woman's work.			Orenburg goat					
Do			do					
SPAIN.								
Marqués de Perales, Madrid.		A	Merino				4 15	2.75
Do		B	do				5 8	2.75
Do		C	do				5 3	2.50
Do		D	do				8 7	2.25
Do		E	do				4 7	3
Do		F	do				4 7	2.50
Do		G	do				4 14	2.75
Ortega Saenz Diente, Cuenca.		H	Merino, black					3
Do		I	Merino, white					2.50
TURKEY.								
Adana		1a	Black goat					9
Do		2a	do					6
Do		3a	do					5.75
Do		4a	do					4.50
Do		5	do					4.50
Do		6	Mohair					7
Do	24381	12						6
Sivas	24389	20a	White fat-tail	Ewe	3 yrs			10
Do		21a	Black fat-tail	do	3 yrs			10
Bordor		22a	Fat-tail		1 yr.			2.50
Province of Angora		22b	Mohair					8
Do		23b	do					10
Do		24b	do					4
Konieh	24360	29a	Fat-tail		1 yr			4.75
Do	24360	29a	do		1 yr			
Brussa	24359	34a						2
Province of Sivas	24371	35	Fat-tail	Ram	4 yrs			10
Smyrna	24378	43a	do	Ewe	3 yrs			6
Do	24378	43a	do	do	3 yrs			3.50
Dardanelles, Mustapha Bey.	24383	131	Lambs' fleece					
Province of Sivas	24381	517						6.75
Province of Bordor	24352	528	Fat-tail					6.25
Province of Konieh	24374	560	do	Ewe				7.50
Sivas	24381	434	do	Lamb				6
Konieh	24374	360	do	Wether	2½ yrs			6.25
Do	24373	561a		Lamb				5
Do	24376	562	Fat-tail	Ewe	4 yrs			9
Do	24392	563	do	Ram	3 yrs			6.50
Do	24375	565	do	do	7 yrs			9
Do	24395	566	do	do	4 yrs			10
Province of Stankeny	24388	567	do	Wether	3 yrs			4
Konieh		564	do	Ewe	2 yrs			1.50
Sinope	24390	616	do	do	Lamb			8.50
Province of Kastamuni	24393							8
URUGUAY.								
Felix Buxarro	26643	1	Three-fourths Vermont.	Ewe	4 yrs		11 0	2
Do	26644	2	Vermont-Gilbert.	do	2 yrs		7 3	2.4

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D^2 \times S}{D^2 S'} =$	$\frac{S}{18109\, D^2} =$	$E = \frac{R}{P}$	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.		R.		
1.911	.752	1/33⅓	5.941	92.68	5.700	28.50	26.02	29,458	103,352	Dressed skins.
2.784	1.096	1/23	12.93	200.540	3.824	19.12	26.69	30,210	158,010	
2.109	.830	1/30	.....	.....	.....	.....	.....	.....	.....	
3.430	1.350	1/18	.....	.....	.....	.....	.....	.....	.....	
6.777	2.668	1/9	3.605	55.63	7.750	38.75	12.55	14,215	36,680	
1.678	.660	1/37½	4.600	70.98	6.740	33.70	26.13	29,582	85,790	Gray.
1.915	.758	1/33⅓	4.600	70.988	7.840	39.20	20.06	22,710	57,948	White.
2.392	.942	1/26⅔	6.900	107.48	6.000	30	19.29	21,835	72,795	
2.329	.917	1/27½	4.625	71.374	6.082	30.41	13.642	15,440	50,775	
1.882	.741	1/34⅓	4.025	62.115	4.908	24.54	18.182	20,578	83,858	
2.306	.907	1/27½	6.983	108.76	6.132	30.66	21.01	23,780	77,561	
1.539	.606	1/42	3.408	52.593	5.132	25.66	23.021	26,055	99,233	
2.067	.813	1/31⅓	4.683	72.269	3.974	19.87	17.537	19,848	99,894	
2.334	.918	1/27½	4.724	72.902	5.424	27.12	13.88	15,358	57,953	
3.051	1.201	1/21	11.133	324.58	5.780	28.90	19.13	21,650	75,445	
2.187	.861	1/29½	4.224	65.186	4.408	22.04	14.13	15,992	72,566	
9.828	3.869	1/6½	.....	.....	.....	.....	.....	.....	.....	
7.824	3.080	1/8⅓	.....	.....	.....	.....	.....	.....	.....	
6.645	2.616	1/9½	.....	.....	.....	.....	.....	.....	.....	
7.042	2.772	1/9	.....	.....	.....	.....	.....	.....	.....	
7.529	2.964	1/8½	.....	.....	.....	.....	.....	.....	.....	
5.959	2.346	1/11	42.20	651.24	7.024	35.12	19.01	21,520	62,700	Coarse.
4.158	1.637	1/15½	33.616	518.75	7.766	38.83	31.104	35,200	90,660	
6.236	2.455	1/10⅓	53.433	824.576	8.274	41.37	21.98	24,881	60,142	
5.091	2.004	1/12½	50.18	774.39	7.740	38.70	30.906	35,060	90,595	
3.770	1.484	1/17	25.23	389.35	8.252	41.26	28.402	32,141	77,911	
3.744	1.474	1/17	31.70	489.30	8.900	44.50	36.183	40,952	92,028	
2.424	.954	1/26⅔	23.01	355.09	8.150	40.75	58.88	70,916	174,020	
3.264	1.285	1/19½	17.275	266.59	7.508	37.54	19.948	36,125	96,231	Fine.
4.831	1.901	1/13⅓	25.64	395.685	8.274	41.37	17.577	19,940	48,089	Coarse.
5.741	2.260	1/11	28.68	442.59	7.358	36.79	13.92	15,753	42,830	
3.747	1.475	1/17	24.758	382.073	7.866	39.33	28.281	32,009	81,386	
5.390	2.122	1/12	31.03	478.86	4.332	21.66	17.065	19,340	89,295	Do.
2.678	1.054	1/24	10.45	161.26	5.182	25.91	23.31	26,380	101,800	Fine.
3.336	1.313	1/19½	19.23	306.76	6.740	33.70	27.645	31,290	92,850	
1.585	.624	1/40	4.491	69.406	4.166	21.83	28.602	32,375	155,410	Do.
2.454	.966	1/26⅔	8.200	126.54	5.174	25.87	21.78	24,656	95,315	Do.
3.018	1.188	1/21	12.433	191.870	5.266	26.33	21.840	24,718	81,905	
3.358	1.322	1/18⅔	.....	.....	.....	.....	.....	.....	.....	
5.373	2.115	1/12	31.658	488.54	8.440	42.20	17.541	19,853	47,040	
4.097	1.612	1/15½	31.55	486.890	8.274	41.37	30.073	34,037	82,276	
4.333	1.706	1/14⅔	13.741	212.05	6.966	34.83	11.70	13,252	38,052	
4.135	1.628	1/15½	46.82	722.54	4.466	22.33	43.81	49,585	22,200	
5.301	2.087	1/12	38.008	586.54	9.732	48.66	21.636	24,488	50,325	
2.543	1.001	1/25	6.833	105.44	6.458	32.29	16.90	19,135	59,258	Do.
2.670	1.051	1/24	21.18	326.85	7.290	36.45	47.536	53,802	147,600	
5.121	2.016	1/12½	41.68	395.68	5.282	26.41	25.429	28,781	108,980	
4.021	1.583	1/16	40.13	620.30	5.162	25.81	39.711	44,946	174,140	Coarse.
1.908	.751	1/33⅓	4.675	72.146	7.700	38.50	20.54	23,250	60,400	
1.946	.766	1/33⅓	5.141	79.337	7.766	38.83	21.72	24,580	63,310	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
URUGUAY—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Felix Buxarro	26645	3	Gilbert	Ewe	4 yrs		8 13	3
Do	26646	4	Shropshire	do	2 yrs		9 11	4
Do	26647	5	Gilbert-Vermont Merino.	Ram	4 yrs		15 0	2.5
Do	26648	6	One-half Vermont Merino.	do	3 yrs		14 8	2.4
Do	26649	7	do	Ewe	6 yrs		14 0	2.5
Do	26650	8	One-half Gilbert, one-half Steinger Merino.	do	4 yrs		6 5	1.90
Do	26651	9	One-half Gilbert Merino.	do	4 yrs		10 14	2.50
Do	26652	10	Shropshire	Ram	3 yrs		8 12	3.5
Do	26653	11	Vermont Merino.	do	3 yrs		5 4	2.50
P. S. Harrison	26654	12	Rambouillet	Ewe	4 yrs		6 3	3.5
Felix Buscareo		13	One-fourth Vermont.	do	5 yrs		6 1	2.4
Do	26655	14	Merino	Ram	4 yrs		7 2	2
P. S. Harrison	26656	15	Rambouillet-Merino.	Ewe	4 yrs		5 4	2.5
Federico Castellanos	26657	16	do	do	2 yrs		4 3	2.5
Domingo Ordonana	26658	17	do	Ram	18 mos		10 10	3.5
Ignacio Urtuley	26659	18	Rambouillet	Ewe	3 yrs		8 14	3.5
Do	26660	19	Rambouillet-Merino.	do	4 yrs		6 12	2.25
Do	26662	21	do	do	3 yrs		9 2	3.50
Do	26663	22	do	do	4 yrs		11 7	3
Do	26664	23	Saxon Merino.	do	3 yrs		10 3	2.5
Do	26665	24	Rambouillet-Merino.	do	4 yrs		11 7	2.50
Federico Castellanos	26666	25	do	do	4 yrs		4 4	2.50
Do		25	Saxony	do	4 yrs		4 4	3.50
Conrad Hughes	26668	27	Lincoln cross	do	4 yrs		8 1	3
Benjamin Martinez	26670	28	Rambouillet-Merino.	do	2 yrs		6 4	2.5
Nanazalah y Maisterra	26669	29	do	Ram	4 yrs		7 4	3
Angel R. Mendez	26671	30	do	do	2½ yrs		4 8	3
Do	26672	31	Lincoln	do	3 yrs		9 12	5.50
Benjamin Martinez	26673	32	Rambouillet-Merino.	do	3 yrs		10 10	2.50
P. Bergheder y Peyre	26675	34	Devon	do	3 yrs		7 0	5.50
Do	26676	35	Rambouillet-Merino.	Ewe	3 yrs		5 10	3.50
Do	26677	36	do	do	2½ yrs		6 11	2.25
Agusto Johnson	26679	38	do	do	3 yrs		5 11	2
Do		38a	do	do	4 yrs			1.75
Do	26681	40	do	Ram	3 yrs			2.25
Do	26682	41	do	Ewe	3 yrs			2.25
Do	26684	43	do	Ram	3 yrs			2.50
Enrique Ohney	26685	44	Lincoln	do	6 yrs		9 8	9.50
Do	26686	45	Rambouillet-Merino.	do	3 yrs			2.25
Do	26687	46	do	Ewe	4 yrs		4 9	3.50
	26683	42	do	do	1 yr		5 4	1.50
Temun Thmegin	26688	47	do	Ram	3 yrs			2.75
José Ma. Castellanos	26689	48	Lincoln cross	Ewe	3 yrs		4 6	3
George Coweld	26690	49	Rambouillet	Ram	4 yrs		5 9	2
D. Etchejoinberry	26692	51	do	do	4 yrs		6 12	3.25
Agusto Johnson	26693	52	do	do	4 yrs		7 5	3.80
Do	26694	53	do	do	3 yrs		5 3	2.50
Do	26695	54	do	Ewe	3 yrs		5 9	2.50
Do	26696	55	Rambouillet-Merino.	do	3 yrs		5 9	2.60
Ruperto Mendez	26697	56	do	Ram	3 yrs		3 7	2.50
Do	26698	57	do	Ewe	2½ yrs		4 13	3.25
Do		57	do	Ram	6 yrs		4 13	
Diego Young	26699	58	do	do	3 yrs		11 4	3

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2} = \frac{R}{E}$	$E = \frac{R}{P}$		Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.				
1.824	.718	23/32	4.033	62.238	5.108	25.54	19.350	21,951	85,951	
4.242	1.670	1 11/16	26.95	416.90	7.740	38.70	23.963	27,121	70,081	
2.149	.846	27/32	7.266	112.13	6.840	34.20	25.17	28,490	83,305	
2.068	.822	13/16	5.916	92.297	6.366	31.83	21.711	24,573	77,201	
1.987	.781	25/32	5.200	80.248	7.190	35.95	21.072	23,850	66,344	
2.060	.811	13/16	5.175	79.862	7.758	38.79	19.556	22,083	56,931	
2.070	.803	25/32	4.675	72.146	6.350	31.75	17.496	19,757	62,228	
3.010	1.185	1 3/16	14.27	220.219	6.366	31.83	25.142	28,522	89,608	
1.923	.757	3/4	3.941	61.818	5	25	17.051	19,299	77,197	
2.081	.819	13/16	6.466	98.785	5.140	25.70	23.889	27,038	105,200	
2.015	.793	25/32	5.850	89.279	5.390	26.95	23.053	26,092	96,817	
2.215	.872	7/8	5.400	83.346	7.008	35.04	17.61	19,931	56,882	
2.007	.790	25/32	4.516	69.692	6.274	31.37	17.938	20,302	64,720	
2.259	.889	29/32	6.975	10.864	6.982	34.91	21.818	24,751	71,516	
1.842	.725	23/32	5.833	89.196	8.016	40.08	27.50	31,132	77,670	
1.786	.703	11/16	4.616	71.235	7.640	38.20	23.15	26,205	68,602	
1.852	.729	23/32	5.850	80.279	6.200	31	27.28	30,880	99,630	
2.015	.793	25/32	4.833	74.584	7	35	19.045	21,555	61,587	
1.946	.766	3/4	4.525	71.374	5.658	28.29	19.54	22,116	81,862	
1.926	.758	23/32	5.208	80.371	7.024	35.12	22.463	25,424	72,393	
2.045	.805	13/16	4.616	71.235	7.132	35.66	17.782	19,988	56,052	
1.716	.675	11/16	4.783	73.812	7.340	36.70	25.988	29,414	80,148	
2.167	.853	27/32	5.491	84.839	5.874	29.37	18.709	21,175	72,098	
2.840	1.1181	1 1/8	14.65	226.06	8.350	41.75	29.06	32,890	78,780	
1.935	.760	3/4	4.958	77.513	6.690	33.45	21.18	23,978	71,688	
2.167	.853	27/32	6.850	105.865	6.816	34.08	23.339	26,414	76,511	
1.961	.772	3/4	5.058	78.056	6.100	30.50	21.044	23,819	78,094	
3.663	1.442	1 7/16	21.66	334.26	8.158	40.79	25.828	29,233	71,667	
2.104	.828	13/16	6.808	106.06	4.532	22.66	24.606	27,849	122,620	
3.747	1.475	1 7/16	19.58	312.16	15.766	78.83	22.313	25,254	32,036	
1.491	.587	19/32	4.383	67.639	4.566	22.83	30.969	35,051	153,530	
1.982	.780	25/32	4.425	68.288	5.740	28.70	18.022	20,398	71,075	
2.060	.811	13/16	5.633	86.930	5.508	27.54	21.310	24,125	93,720	
1.667	.656	21/32	4.158	64.167	5.266	26.33	23.94	27,095	102,430	
2.322	.914	29/32	5.383	83.072	5.682	28.41	16.346	18,500	65,121	
2.043	.804	13/16	5	77.161	5.708	28.54	19.161	21,693	76,010	
2.287	.900	29/32	4.700	72.532	6.290	31.45	14.374	16,241	51,741	
3.465	1.364	1 3/8	18.17	280.40	6.116	30.58	24.214	27,405	89,620	
1.629	.641	21/32	4.050	62.501	5.608	28.04	24.42	27,637	98,568	
2.027	.798	25/32	4.833	74.584	6.682	33.41	18.80	21,281	63,691	
1.872	.7370	3/4	4.358	67.254	7.400	37	19.897	22,520	60,860	
2.073	.816	13/16	7.141	110.202	6.432	32.16	26.58	30,091	93,570	
2.236	.880	7/8	7.258	112.007	6.200	31	23.22	26,288	84,802	
2.043	.804	13/16	5.200	80.248	5.590	27.95	19.933	22,561	80,719	
1.989	.783	25/32	5.408	83.458	6.408	32.04	21.87	24,755	77,261	
2.139	.842	27/32	5.641	87.053	4.366	21.83	19.72	22,325	102,250	
1.954	.769	3/4	5.225	80.634	5.582	27.91	21.89	24,785	88,790	
1.939	.763	3/4	7.766	119.849	5.566	27.83	33.049	37,405	134,450	
1.860	.732	23/32	5.725	88.349	5.724	28.62	26.47	29,977	104,700	
1.578	.621	5/8	5.458	84.229	5.324	26.62	35.07	39,693	149,410	
1.679	.661	21/32	6.050	93.365	5.940	29.70	34.417	38,863	130,850	
1.893	.745	3/4	5.025	77.54	7.458	37.29	22.43	25,390	68,100	
2.116	.833	13/16	7.833	120.981	6.158	30.79	27.99	31,680	102,650	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
URUGUAY—continued.								
						Pounds.	*Lbs. oz.*	*Inches.*
Juan P. Etchegoyen	26700	59	Gilbert	Ewe	3 yrs.		3 12	3
Pedro Castro	26701	60	do	Ram	3 yrs.		8 15	3
Domingo Ordonana	26702	61	do	do	3 yrs.			2.75
Genta y Hambiague	26704	63	do	do	4 yrs.			
Hugo Tiedeman	26710	69	do	do	5 yrs.			3
Manuel Sterling	26716	75	Lincoln	Ewe	2 yrs.		6 7	6
Do	26717	76	Rambouillet-Merino.	do	4 yrs.		14 10	2.25
Do	26718	77	Lincoln	do	1 yr.		6 4	7
Do	26718	77	Rambouillet	Ram	4 yrs.			3
Do	26720	79	do	Ewe	3 yrs.		13 4	2.50
	26719	78	do	Ram	2 yrs.		7 8	3.50
Do	26721	80	do	do	3 yrs.		16 11	2.50
Do	26722	81	Lincoln	do	3 yrs.		10 8	9
Do	26723	82	Rambouillet	Ewe	3 yrs.		13 12	2.50
Do	26724	83	do	do	3 yrs.		14 3	2.5
Do	26725	84	Lincoln	do	4 yrs.		8 4	6.50
Do	26726	85	Rambouillet-Merino.	Ram	14 mos.		13 5	3
Do		85	Lincoln	do			7 8	5.50
Do	26727	86	Rambouillet	do	1 yr.		8 10	2.50
Juan P. Echegoyen	26728	87	Merino	do	4 yrs.			2.75
Miguel Bidart	26731	91	do	do	4 yrs.			2.50
Do	26732	91	do	Ewe	4 yrs.			3.25
Do	26733	92	Lincoln	Ram	4 yrs.			6
Santos L. Urioste	26734	93	do	do	3 yrs.			5.50
Hugo Tiedeman	26735	94	Rambouillet	do	3 yrs.		5 8	2
Do	26736	95	do	do	4 yrs.			3
Do	26737	96	do	Ewe	3 yrs.			3.50
Do	26739	98	do	Ram	4 yrs.			2.50
Do	26740	99	Lincoln	Ewe	2 yrs.		7 3	5
Do	26741	100	do	Ram	4 yrs.		14 12	11
Do	26742	101	Rambouillet-Merino.	do	3 yrs.		16 7	3
Do	26745	104	do	do	14 mos.		11 10	2.5
Do	26746	105	do	do	14 mos.		5 9	1.71
Do	26750	109	do	Ewe	3 yrs.		7 11	2.70
Do		116	do	do	3 yrs.		7 0	3
Do		120	do	Ram	3 yrs.			2.50
Do		122	Rambouillet-Merino.	do	4 yrs.			2.50
James Molins, jr	26764	123	do	do	6 yrs.		7 5	2
Do		126	Lincoln cross	Ewe	3 yrs.			2.50
Do		237	Rambouillet-Merino.	Ram	4 yrs.			4.25
Miguel Birdart	26729	88	do	Ewe	4 yrs.		5 9	2.75
Julian Elro	26683	42	do	Ram	4 yrs.		5 4	2.5
A. Fitz Herbert	26680	39	Negretti and Vermont.	do	3 yrs.		12 4	2.5
Tenta y Hamliague	26705	64	Rambouillet	do	4 yrs.		6 11	2.5
Joagnue Hashuen	26706	65	do	do	5 yrs.		6 6	2.5
T. P. Harrison	26708	67	do	Ewe	4 yrs.		5 13	3.7
Juan C. Caneras	26685	44	do	Ram	6 yrs.		4 4	2
Domingo Ordonana	26658	47	do	do	3 yrs.		6 13	2.7
Ignacio Urtuley	26661	20	Saxony	Ewe	4 yrs.		11 7	3.5
P. Bergheder y Peyre	26674	33	Rambouillet	Ram	3 yrs.		6 6	3
Julian Cirro	26691	50	do	do	4 yrs.		8 15	3.5
Maximo y Ricardo fils	26747	106	do	do	14 mos.		6 4	2.5
VICTORIA.								
Wm. Lewis, Stoneleigh	5446	1	Pure Merino	Ewe	2 4/12 yrs.		7 8	4.11
Do	21686	2	do	do	2 5/12 yrs.		10 2	3.50
Do	21687	3	do	do	2 5/12 yrs.		9 3	4
Do	21688	4	do	do	2 4/12 yrs.		8 10	4
Do	21689	5	do	do	2 4/12 yrs.		7 15	4
Do	21690	6	do	do	2 yrs.		8 4	4
Do	21691	7	do	do	2 yrs.		8 11	4.50
Do	21692	8	do	do	2 4/12 yrs.		7 6	2.50
Do	21693	9c	do	do	2 yrs.		7 5	4
Do	21694	10	do	do	31 mos.		9 8	3.50

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2 S'} = 18109 \frac{S}{D^2} = \frac{S}{R}$	$E = \frac{R}{P}$	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.			
1.900	.748	1/34	4.691	72.493	6.490	32.45	20.79	23,530	74,205
1.855	.730	1/35	4.317	66.621	6.550	32.75	20.07	22,715	69,370
1.900	.784	1/32	3.791	58.604	7.416	37.08	16.80	19,015	51,285
2.297	.904	1/28	7.433	114.70	6.240	31.20	23.593	26,703	85,586
2.667	1.054	1/24	8.088	124.73	5.008	25.04	18.605	20,578	82,184
3.183	1.253	1/20	21.75	335.65	7.940	39.70	34.348	39,781	100,200
2.144	.844	1/30	6.083	93.874	7.300	36.50	21.173	23,964	65,655
3.551	1.398	1/18	18.30	282.41	8.832	44.16	23.22	26,281	59,472
2.066	.813	1/32	4.858	74.870	6.400	32	18.21	20,610	64,408
2.162	.851	1/30	5.525	85.262	6.600	33	18.911	21,404	64,860
2.298	.904	1/28	5.508	85	6.140	30.70	17.474	19,777	64,424
2.467	.971	1/26	5.816	80.754	5.916	29.58	15.29	17,305	58,503
3.056	1.203	1/21	20.641	318.52	7.632	38.16	35.362	40,023	104,884
2.386	.939	1/27	5.900	92.050	6.232	31.16	16.581	18,767	60,229
2.124	.836	1/30	7.050	108.79	5.582	27.91	25.003	28,299	74,648
3.198	1.259	1/20	23.58	36.389	7.516	37.58	36.89	41,752	111,100
2.058	.808	1/32	6.491	100.271	8.366	41.83	24.527	27,888	66,671
2.759	1.086	1/23	21.15	326.39	8.332	41.66	44.455	50,315	120,770
2.535	.998	1/25	7.483	115.48	6.400	32	18.631	21,086	65,896
1.992	.784	1/32	4.541	70.077	6	30	18.31	20,723	69,079
2.043	.804	1/31	5.683	87.702	3.900	19.50	21.785	24,656	126,440
2.276	.896	1/28	5.258	81.143	6.400	32	16.24	18,381	57,440
3.196	1.258	1/20	18.95	293.44	6.866	34.33	29.683	33,596	98,088
3.125	1.230	1/20	16.16	249.38	7.240	36.20	26.476	29,982	82,780
2.030	.799	1/32	4.625	71.374	6.266	33	17.957	20,324	64,871
1.917	.754	1/34	5.558	85.772	6.716	33.58	24.198	27,388	81,562
2.129	.838	1/30	5.008	77.285	6.282	31.41	17.678	20,008	63,700
1.931	.760	1/34	4.508	69.569	6.332	31.66	19.343	21,893	69,152
4.019	1.582	1/16	28.41	438.43	8.708	43.54	28.135	31,991	73,137
3.782	1.489	1/17	30.29	467.53	8.250	41.25	33.88	38,345	92,965
2.129	.838	1/30	5.841	90.140	7.224	36.12	20.618	23,336	64,687
1.911	.752	1/34	5.600	86.421	7.682	38.41	24.53	27,765	72,290
1.961	.772	1/33	5.316	82.035	6.582	32.91	22.11	25,030	76,060
2.043	.844	1/31	5.233	80.757	6.316	31.58	20.06	22,700	71,895
2.048	.806	1/32	5.250	81.019	6.750	33.75	20.02	22,660	67,160
2.467	.971	1/26	5.550	85.649	7.066	35.33	14.59	16,510	46,740
2.215	.872	1/28	4.900	76.185	7.574	37.87	15.97	18,085	47,755
2.388	.940	1/27	4.625	71.374	6.590	32.95	12.97	14,685	44,573
2.627	1.034	1/24	12.03	185.67	6.450	32.25	27.89	31,570	97,885
2.251	.872	1/28	4.583	70.726	8.400	42	14.471	16,378	38,998
1.587	.605	1/42	4.600	70.988	7.190	35.95	31.155	35,261	98,085
1.737	.684	1/37	4.833	74.584	6.858	34.29	25.614	28,990	86,515
1.895	.746	1/34	5.875	90.664	7.940	39.70	26.17	29,626	74,629
1.783	.702	1/36	4.733	73.041	7.590	37.95	23.82	26,960	71,040
1.910	.752	1/34	5.141	79.337	7.474	37.37	22.547	25,519	68,289
1.681	.709	1/36	4.050	62.501	6.352	31.76	55.45	62,762	197,610
1.539	.606	1/42	4.191	64.776	6	30.00	28.311	32,043	106,810
1.797	.706	1/36	4.625	71.374	7.166	35.83	22.91	25,930	72,380
1.966	.774	1/33	4.966	77.637	8.024	40.12	29.556	23,266	58,005
2.390	.941	1/27	4.525	69.831	5.474	27.37	12.67	14,342	52,413

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
VICTORIA—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
Wm. Lewis, Stoneleigh	21695	11	Pure Merino	Ewe	2 4/12 yrs		9 12	3.50
Do	21696	12	do	do	2 4/12 yrs		8 8	3.75
Do	21697	13	do	do	3 yrs		7 13	3.4
Do	21698	14	do	do	3 yrs		8 4	3
Do	21699	15	do	do	3 yrs		5 12	3
Do	21700	16	do	do	3 yrs		6 9	2.5
Do	21701	17	do	do	3 yrs		9 2	4
Do	21702	18	do	do	3 yrs		7 6	3.4
Do	21703	19	do	do	3 yrs		7 1	3
Do	21704	20	do	do	3 yrs		5 3	2.50
Do	21705	21	do	do	3 yrs		7 5	3.9
Do	21706	22	do	do	3 yrs		7 5	3.9
Do	21707	23	do	do	3 yrs		5 8	3.40
Do	21708	24	do	do	3 yrs		7 1	4.30
Do	21709	25	do	do	18 mos		5 15	3
Do	21710	26	do	do	18 mos		7 9	3.4
Do	21711	27	do	do	18 mos		7 15	3.8
Do	21712	28	do	do	18 mos		6 6	3.4
Do	21713	29	do	do	18 mos		6 4	3.78
Do	21714	30	do	do	18 mos		5 15	3.8
Do	21715	31	do	do	18 mos		6 2	3.8
Do	21716	32	do	do	18 mos		5 5	3.4
Do	21717	33	do	do	18 mos		7 1	3.8
Do	21718	34	do	do	18 mos		6 8	3.4
Do	21719	35	do	do	18 mos		5 13	3.4
Do	21720	36	do	do	18 mos		7 8	3.8
Do	5469		do	Lamb				2
Do	5471		do	Ewe	19 mos			4.5
Bailey & Wymne, Terinallium.	5456	1	do	do	2 yrs		8 6	3.5
Do	21753	2	do	do	1 yr		8 4	4.50
Do	21754	3	do	Wether	3 yrs		8 12	4.5
Do		3	do	Ewe	2 yrs		10 12	3.50
Do	5466		do	Ram	3 yrs			3.5
Jos. Mack, Berry Bank	5452	1	Three-fourths Vermont Merino.	do	2½ yrs		14 10	3.5
Do	21741	2	do	do	2½ yrs		17 4	3.5
Do	21742	3	Vermont and Australian Merino.	do	2½ yrs		16 3	3
Do	21743	4	Three-fourths Vermont Merino.	do	2½ yrs		20 0	3
Do	21744	5	Vermont and Australian Merino.	Ewe	17 mos		8 6	3.50
Do	21745	6	do	do	17 mos		6 8	3
Do	21746	7	do	do	17 mos		7 0	3.50
Do	21747	8	do	do	17 mos		8 8	3
Do	21748	9	Three-fourths Vermont Merino.	do	2½ yrs		14 4	3.5
Do	21749	10	Australian-Vermont Merino.	Ewe	5 yrs		4 12	1.10
Do	21750	11	do	do	17 mos		8 0	3.50
Do	21751	12	One-half Vermont Merino.		17 mos		8 5	3.21
Do	21751	13	Merino	Ewe	17 mos		8 0	3.75
Do	21752	13	Australian-Vermont Merino.	do	17 mos		8 0	2.5
J. L. Curry & Co., Larra	5449	1	Merino	do	3 yrs		3 13	3.50
Do	21731	2	do	do	3 yrs		6 1	3.5
Do	21732	3	do	do	3 yrs		3 15	4
Do	21765	4	do	do	3 yrs		13 12	4
Do	5454	15	Pure Merino	do	2½ yrs		6 6	5.1
Do	5455		do	do	2½ yrs		5 6	3.5
Geo. Russell Sons, Barunak Plains.	5458	1	Merino	do	4 yrs		18 12	4.50

of test of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
Centi-milli-meters.	Thou-sandths of inch.	Frac-tion of inch.	Grams.	Grains.	Milli-meters in 20-milli-meter length.	Per cent of length.				
2.045	.805	1/31	4.288	66.096	5.024	25.12	16.768	18,546	73,830	
1.646	.648	1/39	5.716	88.211	7.332	36.66	33.756	88,205	104,215	
1.659	.653	1/39	5.250	81.019	6.850	34.25	30.520	34,543	100,855	
1.930	.760	1/33	6.491	100.271	6.458	32.29	27.879	31,556	97,729	
1.801	.709	1/36	6	92.594	6.432	31.66	29.596	33,498	105,804	
2.053	.808	1/31	6.541	100.94	7.424	37.12	24.83	28,105	75,710	
2.208	.869	1/29	6.083	93.87	6.682	33.41	19.96	22,595	67,630	
1.885	.742	1/34	4.325	66.744	5.974	29.87	19.430	21,991	73,624	
1.7031	.703	1/37	4.266	65.834	5.516	27.58	23.532	26,634	96,569	
1.878	.739	1/34	4.216	80.495	5.816	29.08	18.791	21,273	73,155	
2.082	.800	1/32	4.341	66.991	5.308	26.54	16.821	19,038	93,009	
1.603	.631	1/40	6.158	95.092	6.682	33.41	38.34	43,395	129,850	
1.9865	.782	1/28	4.095	63.289	5.666	28.33	16.603	18,791	66,330	
1.740	.685	1/36	4.125	63.658	5.290	26.45	21.804	24,678	93,302	
1.778	.698	1/36	3.106	47.932	3.966	19.83	15.808	17,892	90,230	
1.865	.734	1/34	4.700	72.532	6.350	.3175	21.62	24,470	77,075	
2.0475	.806	1/31	7.400	114.199	7.682	.3841	28.242	31,965	83,221	
1.5675	.617	1/40	5.491	84.839	6.216	.3108	35.756	40,469	130,211	
1.847	.727	1/34	4.358	67.254	5.724	.2862	20.439	23,133	82,713	
1.5445	.608	1/41	3.491	53.974	5.390	.2695	23.415	26,501	98,335	
1.692	.666	1/38	5.441	85.967	7.658	.3829	30.408	34,416	89,885	
1.601	.630	1/40	4.033	62.238	5.032	.2516	25.761	28,493	113,347	
1.9585	.771	1/33	4	61.729	6.458	.3229	16.68	18,884	58,470	
1.5775	.621	1/40	3.516	54.260	5.708	.2854	22.606	25,586	89,629	
1.839	.724	1/35	3.733	57.608	6.040	.3020	17.660	19,988	66,188	
1.773	.698	1/36	5.400	83.334	6.800	.3400	23.340	31,108	91,493	
1.652	.652	1/39	5.400	83.334	5.616	.2558	31.658	35,831	125,360	
1.812	.713	1/36	4.666	72.007	6.066	.3033	22.73	25,730	84,850	
1.867	.735	1/35	3.758	57.904	6.900	.3450	16.857	19,079	55,302	
2.1565	.849	1/30	4.391	67.863	7.686	.3843	15.107	17,099	44,494	
1.8365	.723	1/35	4.775	73.689	6.532	.3266	22.652	25,638	78,499	
1.8925	.745	1/34	5.483	84.615	7.250	.3625	22.869	25,872	70,250	
2.263	.890	1/28	7.450	114.97	6.090	.3045	23.291	26,361	86,572	
2.325	.915	1/27	6.391	98.726	5.566	.2783	18.916	21,410	76,931	
1.9865	.782	1/28	4.850	74.847	6.124	.3060	19.774	22,267	73,464	
2.263	.891	1/28	4.208	64.939	6.974	.3487	13.147	14,880	42,672	
2.4715	.973	1/27	5.941	92.683	7.982	.3991	16.264	18,408	46,124	
1.824	.718	1/35	4.833	74.684	7.616	.3808	23.242	26,305	67,799	
1.689	.665	1/38	4.541	70.078	6.140	.3070	25.463	28,819	93,874	
2.162	.851	1/29	4.700	72.532	5.974	.2987	16.088	18,208	60,950	
1.928	.759	1/33	4.325	66.744	6.558	.3279	18.616	21,070	64,257	
2.370	.933	1/27	8.	123.458	6.150	.3075	22.788	25,792	83,877	
2.0805	.819	1/31	4.825	74.461	5.658	.2829	17.835	20,181	89,830	161 days.
1.664	.655	1/38	7.083	109.30	7.932	.3966	22.91	25,938	76,020	
1.796	.707	1/34	5.491	84.83	5.482	.2741	27.23	30,820	112,400	
1.814	.714	1/35	4.208	65.03	4.658	.2329	20.46	23,158	99,432	
2.129	.838	1/29	5.266	81.26	5.66	.3283	18.58	21,035	64,080	
1.933	.761	1/33	4.675	72.146	7.216	.3608	20.018	22,657	62,434	
1.7985	.708	1/35	5.266	81.266	4.582	.2291	20.062	29,497	128,740	
1.771	.697	1/34	4.950	77.390	6.782	.3391	22.113	25,028	58,626	
2.312	.910	1/28	5.333	82.300	8.424	.4212	26.161	29,609	70,297	
1.560	.614	1/41	5.058	78.056	7.450	.3725	33.254	37,637	101,040	
1.809	.712	1/35	5.391	83.295	6.374	.3187	26.357	29,832	93,605	
1.6995	.669	1/38	4.275	65.973	7.8416	.39208	23.681	26,803	68,361	

Details of history and average results

FOREIGN—Continued.

Name and address.	Record No.	Exhibit No.	Breed.	Sex.	Age.	Live weight.	Corrected weight of fleece.	Corrected length of fiber in crimp.
VICTORIA—continued.						*Pounds.*	*Lbs. oz.*	*Inches.*
J. L. Curry & Co., Larra..	21763	2	Merino	Ewe	2 yrs		10 5	4
Do	21764	3	do	do	2 yrs		10 13	4
Do	21768	7	do	Ram	4 yrs		12 8	4.50
Do		27	do	Ewe	3 yrs		13 12	3
Do	5468f		do	do				3.50
Geo. Russell	21766	5	do	do	4 yrs		12 12	4
Do	21767	6	Pure Merino	do	3 yrs		12 4	4
Do	21769	8	do	do	2 yrs		12 0	4.50
Do	21770	9	Merino	do	2 yrs		9 7	4
Do	21771	10	do	do	2 yrs		12 6	3.50
Do	21772	11	do	do	4 yrs		13 0	4
Do	21773	12	do	do	4 yrs		10 8	4
T. Russell, Wurrook, Rokewood.	21756	2	do	do	2 yrs		8 4	4.7
Do	21758	4	do	do	3 yrs		7 13	3.84
Do	21759	5	do	do	2 yrs		6 0	3.4
Do	21760	6	do	Ram	Aged		10 10	3.40
Do	21762	8	do	Ewe	1 yr		8 9	2.57
Do		9	do	do	Aged		8 4	2
Do	5457		do	do	2 yrs		8 4	4.75
T. Russell & Son, Wurrook, Rokewood.	5457		do	do	3 yrs			
Do	21761	7a	do	Ram	Aged		16 15	3.8
Russell Bros., Carrigham	21721	2	do	Ewe	2 yrs		10 2	4
Do	21732	3	do	do	3 yrs		3 15	4
Do	21733	4	do	do	3 yrs		4 9	3.50
Do	21724	5	do	do	2 yrs		9 8	4
Do	21725	6	do	do	2 yrs		10 4	4
Do	21726	7	do	Ram	2 yrs		15 12	3.50
Do	21727	8	do	do	2 yrs		13 13	4
Do	21729	10	do	do	2 yrs		13 4	4
Do	21730	11	do	do	2 yrs		16 14	3.50
Do		12	do	do	2 yrs		14 0	4
Do	4447		do	Ewe				
Do	4447		do	do	2 yrs			
Do	21728	9	do	Ram	2 yrs		15 11	4
W. Cumming & Son, Mount Fyans.	21774	2	do	Ewe	4 yrs		16 14	4.5
Do	21775	3	Pure Merino	do	4 yrs		11 0	3.50
Do	21776	4	Merino	do	3 yrs		8 6	4.25
Do	5459	1	Pure Merino	Ram	5 yrs		11 3	4
Mrs. F. Ritchie, Blythevale.		G	Merino	Ewe	4 yrs		4 11	2
Do	5451	A	do	Lamb	2 yrs		2 14	3
Do	21734	B	do	Ram	2 yrs		5 15	3.50
Do	21735	C	do	do	2 yrs		5 0	4
Do	21736	D	do	do	2 yrs		6 2	4
Do	21737	E	do	do	2 yrs		3 2	3.50
Do	21738	F	do	do	2 yrs		13 2	4
Do	21739	H	do	do	2 yrs		3 6	3
Jno. Saunderson & Co., Brie Brie.	5465	17	do	Ewe	2 yrs			3.5
N. G. Elder, The Meadows.		64	do					
Robt. Simson, Langikalkal.	5460		Linsey					1.75
Do	5461		Pure Merino					3.25
Wm. Davidson	5461		do	Ram				2
Do	5463		do	do				2.50
Do		42						1.75
Sir Wm. Clark	21761	7	Second cross Merino-Leicestershire.	Ram				5.25

of tests of individual samples of wools—Continued.

FOREIGN—Continued.

Fineness of fiber.			Strength of fiber.		Total stretch of fiber.		$\frac{D'^2 \times 8}{D^4 S'} = 18109 \frac{8}{D^2} = \frac{S}{R}$.	$E = \frac{R}{P}$.	Remarks.
Centi-millimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20-millimeter length.	Per cent of length.			
2.245	.884	1/28	3.975	62.343	6.890	.3445	12.613	14,276	41,439
1.959	.771	1/32	3.916	61.433	5.658	.2829	16.326	18,478	65,318
2.007	.790	1/32							
1.702	.670	1/38	4.808	74.198	6.682	.3341	26.55	30,050	89,962
1.679	.661	1/38	4.691	72.498	6.932	.3466	26.624	30,133	86,941
1.7985	.708	1/36	4.491	69.406	6.432	.3216	22.214	25,143	78,180
2.2075	.869	1/30	4.208	64.939	6.366	.3183	13.81	15,637	49,128
1.895	.746	1/34	4.000	61.729	8.150	.4075	17.822	20,171	49,500
2.065	.813	1/32	4.350	67.130	6.958	.3479	16.321	18,473	53,099
2.1565	.849	1/30	3.991	62.680	5.890	.2945	10.658	12,063	40,963
1.890	.744	1/34	4.925	77.003	6.408	.3204	22.06	24,960	77,920
1.819	.716	1/36	3.783	58.380	7.316	.3658	18.293	20,704	71,420
1.969	.775	1/32	8.633	133.225	7.066	.3533	35.62	40,324	114,100
1.9025	.749	1/34	4.641	71.621	7.540	.3770	20.515	23,219	61,590
2.058	.810	1/32	4.166	64.289	5.458	.2729	15.734	17,812	65,270
2.0525	.808	1/32	5.883	90.788	7.490	.3745	22.35	25,300	67,558
1.758	.692	1/36	4.333	66.868	6.582	.3291	22.43	25,380	77,140
2 055	.809	1/32	5.066	78.180	7.074	.3537	19.198	21,723	61,418
2.004	.789	1/32	4.927	77.035	7.066	.3533	20.712	23,442	66,352
1.845	.768	1/30	3.691	57.060	6.466	.3233	14.70	16,639	51,462
1.946	.766	1/30	3.975	62.343	6.450	.3225	16.039	18,152	56,290
1.994	.785	1/32	4.541	70.072	7.474	.3737	18.273	20,682	55,344
1.8925	.745	1/34	5.483	84.615	7.250	.3625	22.869	25,872	70,250
1.806	.711	1/36	7.458	115.094	7.250	.3625	36.584	41,400	114,200
2.2465	.900	1/30	5.366	82.809	7.090	.3595	16.422	18,163	51,700
2.480	.976	1/28	6.483	100.047	6.708	.3354	16.86	19,085	56,910
2.167	.853	1/30	4.1863	64.604	7.3416	.3671	14.263	16,144	45,220
1.7985	.708	1/36	4	61.729	8.150	.4075	19.79	22,406	54,985
2.291	.902	1/30	5.516	85.124	8.250	.4125	16.815	19,031	46,136
1.997	.786	1/32	4.250	66.587	7.116	.3558	17.05	19,300	54,240
2.126	.837	1/30	4.683	72.269	8.558	.4279	16.577	18,762	43,847
1.992	.784	1/32	5.441	83.967	6.224	.3112	21.938	31,260	100,450
2.060	.807	1/32	5.375	82.948	6.100	.3050	20.463	23,161	75,989
1.918	.755	1/32	6.183	96.417	8.240	.4120	26.891	30,436	73,870
1.7705	.697	1/36							
1.715	.675	1/36	5.483	84.615	14.566	.7283	29.82	33,758	41,194
2.129	.838	1/30	5.366	82.789	7.874	.3937	16.06	18,178	46,170
2.291	.902	1/30	5.616	86.668	6.840	.3420	17.119	19,376	56,650
1.700	.669	1/36	5.016	77.407	7.324	.3662	27.77	31,430	85,830
1.814	.714	1/36	3.791	58.504	6.408	.3204	32.947	37,290	119,095
1.963	.773	1/32	4.499	79.540	6.016	.3008	18.680	21,143	70,290
1.875	.738	1/32	4.183	64.558	7.566	.3783	19.037	25,546	56,956
1.675	.660	1/32	4.491	69.406	8.250	.4125	25.566	28,935	70,146
1.4225	.560	1/30	3.466	53.488	6.732	.3366	27.425	31,040	92,217
2.205	.868	1/32	4.816	74.32	6.090	.3045	15.84	17,930	58,900
2.007	.790	1/32	5.158	79.60	6.758	.3379	20.53	23,245	68,780
1.575	.620	1/36	4.866	75.091	6.016	.3008	31.384	35,521	188,100
2.088	.823	1/32	4.941	77.251	6.558	.3279	18.133	20,523	62,590
1.558	.613	1/36	5.200	80.248	6.058	.3029	34.245	38,793	128,070
1.779	.700	1/36	4.141	63.905	5.290	.2645	29.44	23,705	89,623
1.654	.651	1/36	4.266	65.834	5.632	.2816	24.949	28,238	100,270
1.271	.500	1/30	3.166	48.858	6.132	.3066	31.357	35,490	85,480
1.761	.693	1/32	5.925	92.436	6.990	.3492	30.499	34,598	98,996
1.946	.766	1/30							

Details of history and average results of tests of individual samples of wools—Continued.

EXHIBIT OF CARL GRÜBNAU.

Country.	Exhibit No.	Kind of fiber.	Corrected length of fiber in crimp.	Fineness of fiber.			Strength of fiber.		Stretch of fiber.		$\frac{D'^2 \times S}{D^2} = S'$.	$18109\frac{S}{D^2} = R$.	$E = \frac{R}{P}$.	Remarks.
				Centimillimeters.	Thousandths of inch.	Fraction of inch.	Grams.	Grains.	Millimeters in 20 meters length.	Per cent of length.				
			Inches.											
Arabia	51	Bagdad fleece	2.25	2.886	1.136	$\frac{1}{880}$	19.36	308.76	6.974	34.87	35.57	42,090	120,700	Brown.
	53a	....do	4	3.496	1.376	$\frac{1}{726}$	14.95	231.69	6.54	32.7	19 574	22,142	67,720	Gray.
	53b		3 50	2.655	1.045	$\frac{1}{956}$	15.46	238.57	5.9	29.5	35.09	39,710	134,600	
	54	Bagdad		2.401	.945	$\frac{1}{1057}$	9.650	158.92	6.416	32.08	26.783	30,313	94,494	Fawn.
	55	....do	6	3.028	1.192	$\frac{1}{838}$	13.03	201.08	7.766	38.83	22.738	25,734	66,276	Washed.
	56	....do	3	2.858	1.125	$\frac{1}{888}$	10.46	161.42	7.532	37.66	20.48	23,190	61,575	Black.
	54	....do		9.526	3.7503	$\frac{1}{266}$	32.96	509.63	5.932	29.66	5.811	6,577	72,176	Coarse.
Argentine Republic	57	Fleeces	4.50	1.497	.589	$\frac{1}{1698}$	5.075	78.319	7.832	39.16	36.23	41,010	104,800	
	58	....do	1.50	1.685	.663	$\frac{1}{1507}$	5.866	90.526	6.282	31.41	33.579	37,410	119,100	
Asiatic Russia	75	Turkestan wool, bale	5	2.761	1.087	$\frac{1}{919}$								Washed.
Asiatic Turkey	26	Mohair	9	2.688	1.058	$\frac{1}{944}$	24.275	374.597	8.282	41.41	53.74	60,820	146,800	
	74	Aleppo shin wool	8	3.630	1.429	$\frac{1}{700}$	37.81	583.48	8.766	43.83	45.90	51,960	118,500	
Australia	65	Port Phillip superior lamb's	1.25	2.055	.809	$\frac{1}{1238}$	6.541	100.94	8.550	42.75	24.78	28,045	65,610	
	66	New Zealand superior cross-bred, scoured.		2.002	.788	$\frac{1}{1268}$	8.716	134.50	6.824	34.12	27.63	39,380	115,400	
	67	Adelaide superior fleeces	3.50	1.481	.583	$\frac{1}{1741}$	5.966	92.068	8.182	40.91	43.52	49,250	120,400	
	68	Port Phillip superior fleeces	3.25	1.631	.642	$\frac{1}{1587}$	5.300	81.790	3.700	18.50	31.87	36,040	194,800	
	69	Queensland superior fleeces	3.25	1.809	.712	$\frac{1}{1403}$	6.500	100.31	6.824	34.12	31.78	35,960	405,400	
	70	New South Wales superior fleeces.	3.50	1.939	.763	$\frac{1}{1309}$	4.383	67.63	6.508	32.54	18.65	21,110	64,870	
							5.700	87.963	6.874	34.37	34.36	38,900	113,100	Do.
	71	....do		1.629	.641	$\frac{1}{1559}$								
	72	....do	2	1.499	.590	$\frac{1}{1694}$	4.333	65.866	6.432	32.16	30.853	34,920	108,570	
Cape Colony	28	Mohair fleeces	6.50	8.564	1.403	$\frac{1}{713}$	23.48	362.34	9.032	45.16	29.57	32,710	72,430	
	59	Extra superior Kaffir fleeces	4	2.060	.811	$\frac{1}{1233}$	7.875	121.53	8.190	40.95	23.58	26,687	65,770	
	60	Superior fleeces	1.50	1.618	.637	$\frac{1}{1569}$	4.683	72.260	6.932	34.66	28.62	32,390	93,460	
	61	Superior snow-white western fleeces.		1.903	.749	$\frac{1}{1334}$	5.556	85.740	6.974	34.87	24.59	27,830	79,820	Do.
	62	Extra superior fleeces	3	1.525	.600	$\frac{1}{1666}$	4.375	67.550	6.190	30.95	30.10	34,065	110,000	
	73	....do		6.970	2.744	$\frac{1}{364}$								Do.
China	1	Superior camel's hair		1.451	.571	$\frac{1}{1750}$	7.050	108.798	7.416	37.08	53.57	60,638	163,520	Fine.
	1	....do		3.290	1.2952	$\frac{1}{771}$	50.50	779.333	8.540	42.70	74.64	840,483	197,880	Coarse.
	2	Camel's hair, second quality		2.347	.924	$\frac{1}{1082}$	5.491	84.839	7.166	35.83	15.55	17,600	49,121	Fine.
	2	....do		2.759	1.086	$\frac{1}{920}$	46.833	722.726	8.240	41.20	98.60	111,400	270,400	Coarse.
	3	Camel's hair, third quality		2.068	.8141	$\frac{1}{1228}$	7.900	122.91	7.282	36.41	29.556	33,451	91,870	Fine.
	3	....do		5.456	2.1480	$\frac{1}{466}$	51.46	794.13	8.250	41.25	27.66	30,590	74,160	Coarse.
	21	Brown cashmere		1.497	.5893	$\frac{1}{1698}$	4.800	74.084	5.600	28	34.27	38,787	138,520	
	22	White cashmere		1.672	.6582	$\frac{1}{1519}$	5.125	79.089	6.540	32.70	29.332	33,198	101,520	Fine.
	23	White ball wool		2.457	.9673	$\frac{1}{1033}$	8.341	128.721	8.100	40.50	22.11	25,020	61,780	

	24	Extra superior lamb's	2.75	2.378	.9362	1/1088	6.283	96.960	7.182	35.91	17.87	20,120	56,030	
	76	White fleece wool	2.25	2.060	.8110	1/1233	7.491	115.70	6.258	31.29	28.24	31,960	102,100	Do.
	79	Woosie wool	2.25	2.487	.9791	1/1021	9.616	158.39	5.868	29.34	24.875	28,153	95,952	
East India	49	White Kandahar	3	1.814	.714	1/1400	4.558	70.339	4.968	24.84	22.160	25,080	100,950	
	50	White Ioria	2.25	3.996	1.573	636	25.48	393.216	8.200	41	25.53	28,900	72,120	
	77	Soft gray wool		3.767	1.483	674	28.80	444.45	7.460	37.33	33.325	38,590	108,400	
Egypt	32	Extra white	5.25	3.968	1.562	640	19.09	304.703	8.224	41.12	19.39	21,950	53,290	Washed.
England	17	Lincoln hogs	13	3.605	1.419	704	21.58	333.02	6.850	34.25	26.568	30,070	87,796	
	18	Kent	8	3.965	1.561	640	17.16	264.81	6.774	33.87	17.464	19,766	58,358	Do.
	19	Willshire hogs	3.50	2.777	1.093	914	9.925	164.16	4.458	22.29	20.592	23,300	104,500	
	20	Willshire half-bred hogs	6.50	3.531	1.390	719	16.100	248.46	7.668	38.34	16.41	19,000	48,440	
Germany	13	Calf hair		4.588	1.806	553	38.22	601.82	5.382	26.91	43.90	49,690	184,600	
	14	.....do		5.182	2.040	490								
Ireland	25	Superior wool hogs	6	2.589	1.019	980	15.71	242.44	7.266	36.33	37.50	42,443	116,820	Do.
Iceland	52	White		4.544	1.789	559	12.308	189.94	7.174	35.87	9.531	10,780	30,074	Do.
Morocco	47	Abudia fleeces	2	3.369	1.326	753	9.825	161.62	6.640	33.20	13.85	15,670	47,210	
	48	Mogadore superior fleeces		2.660	1.047	954	9.591	158.11	7.290	36.45	21.14	23,930	65,660	Do.
Peru	4a	Isley alpaca	8	2.929	1.153	867	7.720	119.13	8.200	41	14.39	16,290	39,742	
	4b	.....do	9	3.323	1.308	764	10.71	165.28	8.850	44.25	15.51	17,563	39,695	
	5	.....do	5.25	3.325	1.309	763	9.630	158.61	4.524	24.62	14.81	16,765	68,381	
	6a	.....do	6.50	5.279	2.078	481	10.56	162.96	8.666	43.33	26.62	30,135	69,555	
	6b	.....do												
	7	.....do	4	2.160	.850	1/1176	6.100	94.137	8.290	41.45	20.91	23,670	57,120	
	8	.....do	5	2.050	.807	1/1238	7.100	109.56	8.332	41.66	27.03	30,590	73,430	
	9	.....do	3.50	2.350	.925	1/1080	6.800	104.93	6.790	33.95	19.701	22,298	65,679	
	10	.....do	7	2.535	.998	1/1001	8.350	128.86	8.040	40.20	21.76	23,530	58,580	Fine.
	10	.....do		3.816	1.502	666	10.49	161.98	7.324	36.62	12.62	14,280	39,018	Light brown.
	10	.....do		4.151	1.634	611	31.79	489.20	8.882	44.41	29.367	33,238	78,445	Coarse white.
	10b	.....do	9.50	2.337	.920	1/1088	24.63	380.09	9.440	47.20	72.15	81,660	173,050	
	12	Vacuna fleeces			.393	2/535	4.263	65.788	6.900	34.50	69.796	77,198	223,760	
	29	White	3.75	2.520	.992	1/1007	9.016	149.13	7.902	39.51	22.716	25,710	65,072	
	30	Superior Lima	3	1.763	.694	1/1440	5.883	90.788	7.090	35.45	11.829	34,275	96,988	
	63	Isley alpaca		3.236	1.274	784	9.716	159.94	8.908	44.54	14.844	16,802	37,723	
Portugal	33	Castel Brangs	4	2.403	.946	1/1056	34.46	531.78	8.340	41.70	95.48	10 560	25,320	Washed.
	34	White	7	2.932	1.154	866	14.80	228.39	6.258	31.29	27.544	31,176	99,630	
Russia	11	Best Russian hair	5.50	1.933	.761	1/1313	9.233	152.486	7.124	35.62	39.53	44,750	125,300	Noils.
	15	Siberian cow hair	2.75	2.853	1.123	890								
	16	.....do	4	3.455	1.360	735								
	37	Lavolski white lamb's	2.50	3.945	1.553	643	23.26	35.895	7.450	37.25	23.913	27,010	72,658	
	38	Lavolski white autumn	3	2.721	1.071	933	41.83	645.53	8.366	41.83	24.359	27,192	65,006	
	39b	Georgian one-half washed	4	3.756	1.478	676	24.20	373.44	9.324	46.62	27.57	31,090	66,550	
	36	Turkestan white	3.25	2.731	1.073	930	16.23	250.46	9.058	45.29	34.817	39,406	87,009	Coarse.
	40	Donskoi white fleeces	7.50	3.864	1.521	657	39.95	627.52	8.016	40.08	42.81	48,456	120,880	
	41	Georgian lamb's	4.50	3.049	1.200	832	20.516	316.609	8.150	40.75	33.09	37,450	91,910	
	42	.....do	3.25	4.446	1.750	571	25.283	390.175	4.474	22.37	20.46	23,160	103,600	Washed.
	55	Superior camel's hair		1.847	.727	1/1375								Fine.
	55	.....do	6	8.939	3.519	284	8.016	123.705	8.082	40.41	37.59	42,550	105,300	
	78	Donskoi lamb's wool	3	5.335	2.100	476	42.08	649.393	7.590	37.95	14.780	26,770	81,560	
Spain	31	Black fleece	3.50	2.480	.976	1/1024	8.455	130.480	6.516	32.58	21.996	24,894	76,410	
Thibet	27	White fleece	3	2.386	.939	1/1065	10.75	16.589	6.400	32	29.524	33,416	104,420	
Uruguay	64	Montevideo fleeces, cross-bred line	2.75				6	92.594	6.950	34.75	26.51	30,000	86,340	

RECAPITULATION AND CONCLUSIONS.

In the preceding tables we have presented the averages of the results obtained from the measurements of individual samples, and with them the history of the samples so far as this was given and can be stated in tabular form. The tables must serve for extended study in many lines, and it is hoped that there are those interested in the various branches of sheep breeding and woolgrowing who will take it up and work out the relations to be found having practical value to all concerned. In the present work we have undertaken to do this to a limited extent, as time and opportunity have allowed, and in the following tables have brought together general averages of the results for each sex in the different breeds as shown in the material offered by the several countries represented. The figures of this table are intended to exhibit as far as possible all the qualities of the staple, and include the weight of the fleece and the length, fineness, strength, and elasticity of the staple.

The number of samples represented in each quality is given along with the figures for that quality. Since the fineness, strength, and elasticity as we have stated them are closely interdependent and the number of samples represented in each is necessarily the same, we have given this figure only once in front of the column for fineness. The table will otherwise explain itself.

Averages of all measurements for each sex in the several breeds.

FOREIGN WOOLS.

Breed and sex.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
ARGENTINE REPUBLIC.										
Ewes:		*Lbs. ozs.*								
Merino	8	7 0	11	2.65	12	2.126	0.837	1/1 0 2	23,167	71,841
Rambouillet-Merino	23	7 5	25	2.75	25	2.192	.863	1/1 0 2	21,956	68,185
Black-top Negretti Merino	1	11 2	1	2.50	1	2.261	.890	1/1 0 2	21,725	70,285
Merino cross	2	4 1	2	3.25	2	2.283	.899	1/1 0 2	31,730	88,042
Grade Merino	124	5 13	125	2.65	125	2.127	.8375	1/1 0 2	21,944	70,659
Lincoln	14	8 6	14	7.50	14	3.526	1.388	7/8	34,802	83,714
Lincoln cross	61	6 14½	62	5.05	62	2.891	1.138	1/8	35,545	89,146
Lincoln second cross	2	5 0	2	3.25	2	3.457	1.361	7/32	18,245	62,282
Merino, cross Southdown	2	7 3	2	7.50	2	1.915	.754	1/1 0 2	24,129	74,775
Rams:										
Black-top Negretti Merino	1	14 1	1	2.50	1	2.598	1.021	1/8	14,104	41,742
Lincoln	8	13 4	8	8.40	9	3.600	1.4	1/8	41,995	70,132
CANADA.										
Wether:										
Grade Shropshire Down	1	.....	1	4.50	1	3.823	1.505	1/32	31,087	77,718
Shearling Shropshire	.....	.....	1	4.50	1	2.611	1.028	1/32	38,559	102,926
Shearling (Shropshire?)	1	.....	1	5.50	1	4.013	1.580	1/32	20,495	61,100
CAPE COLONY.										
Ewes:										
Merino	52	7 3	51	3.09	52	1.841	.725	1/1 0 2	28,775	87,355
Rambouillet-Merino	9	7 0	9	2.80	9	1.956	.770	1/1 0 2	22,112	76,781
Spanish Merino	3	8 0	3	4.23	3	1.910	.752	1/1 0 2	25,800	78,421
Merino, Australian blood	2	8 3	2	3.90	2	1.600	.630	1/1 0 2	32,056	92,212
Merino, Karroo	4	5 9	4	3.48	4	1.585	.624	1/1 0 2	35,776	101,532
Rams:										
Merino	6	9 1	6	2.94	6	1.882	.741	1/1 0 2	28,760	99,281
Rambouillet-Merino	2	5 8	2	3.15	2	1.803	.710	1/1 0 2	22,622	78,856
Merino, Tasmanian blood	2	12 3	2	2.85	2	1.963	.773	1/1 0 2	26,679	84,765
Wethers:										
Merino	34	6 10	34	3.03	34	2.003	.7887	1/1 0 2	26,244	90,056
Rambouillet-Merino	3	5 6	3	3.75	3	1.966	.782	1/1 0 2	26,859	87,776
Lambs:										
Merino	4	6 3	4	2.90	4	1.864	.734	1/1 0 2	31,677	85,238
Rambouillet-Merino	3	5 14	3	2.40	3	2.111	.831	1/1 0 2	22,456	58,320

Averages of all measurements for each sex in the several breeds.—Continued.

FOREIGN WOOLS.—Continued.

Breed and sex.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
NEW SOUTH WALES.										
Ewes:		*Lbs. ozs.*								
Merino	66	9 7	65	3.29	68	1.900	.748	1/1336	26,496	83,758
Australian Merino	14	11 14	13	2.99	15	1.923	.757	1/1320	24,940	82,024
Spanish Merino	6	13 3	6	3.75	6	1.859	.732	1/1392	23,069	71,815
Saxony Merino	8	11 8	8	2.78	8	1.913	.753	1/1347	25,549	86,701
American-Spanish Merino	1	12 9	1	3.75	1	1.951	.768	1/1326	24,144	75,451
Lue-bred Merino	5	12 13	5	3.85	5	2.009	.791	1/1264	24,817	74,382
Cassilis-bred Merino	3	6 10	3	3.30	3	1.915	.754	1/1326	26,298	92,473
Goorlanawa-bred Merino	1	11 8	1	3.50	1	1.750	.689	1/1451	28,208	105,450
Colombo ram, cross Butherwah ewe	3	10 11	3	4.40	3	1.895	.746	1/1340	27,683	105,735
Three-fourths Tasmanian ewe, by Havilah ram	1	8 2	1	3.40	1	1.941	.764	1/1309	20,481	58,803
One-fourth Vermont Merino	1	8 4	1	3.35	1	1.893	.745	1/1341	19,890	60,967
Collaroy ram	1	14 4	1	3	1	2.449	.964	1/1037	21,890	63,839
One-half American Vermont Merino	1	7 6	1	2.08	1	1.961	.772	1/1295	24,995	73,712
Tasmanian Merino	1	9 12	1	3	1	2.063	.812	1/1231	18,151	68,989
Lincoln	2	13 0	2	9.60	2	3.881	1.528	1/654	49,208	109,460
Leicester	3	4 0	2	7.68	3	3.571	1.406	1/711	32,454	104,702
Lincoln, cross Merino	3	10 4	3	4.52	3	2.756	1.085	1/921	39,923	115,556
Rams:										
Merino	21	14 4	21	3.67	22	1.936	.762	1/1311	24,449	78,817
Australian Merino	6	18 13	5	3.35	7	2.020	.795	1/1257	25,468	82,262
Spanish Merino	1	18 4	1	3.50	1	1.646	.648	1/1543	26,174	72,125
Saxony Merino	5	9 11	5	2.90	5	1.786	.703	1/1421	28,175	89,430
Lue-bred Merino	7	16 7	7	2.60	8	2.146	.845	1/1183	21,196	68,202
Lees Lanas Laket Merino	2	8 9	2	2.36	2	1.903	.749	1/1334	15,304	67,412
Goulburn Merino	2	12 14	2	3.20	2	1.976	.778	1/1285	25,989	75,554
Three-fourths Australian-Vermont Merino	3	11 11	3	1.80	3	1.788	.704	1/1420	23,909	77,381
American-Spanish Merino	2	16 1	2	3.36	3	2.294	.903	1/1107	16,823	53,891
Collaroy ram, cross Australian ewe	2	18 15	2	2.62	3	2.436	.959	1/1043	18,184	58,874
Seven-eighths Vermont Merino	1	18 12	1	2.01	1	2.101	.827	1/1208	19,896	56,929
Lincoln	3	18 5	2	11.93	3	3.348	1.318	1/759	39,053	89,617
Leicester	3	11 7	3	6.28	3	8.660	1.441	1/693	28,960	76,684
Wethers:										
Merino	1	12 5	1	3.26	1	2.025	.797	1/1254	18,933	63,751
Lincoln, cross Merino	2	14 3	2	3.70	2	3.168	1.217	1/821	26,126	79,807

NEW ZEALAND.										
Ewes:										
Merino			5	2.90	6	1.854	.730	1/3.89	25,178	101,436
Merino, cross Tasmanian stock			2	7.75	2	2.710	1.067	1/2.57	35,068	100,690
Rams:										
Merino			6	4.83	7	2.281	.898	1/3.13	30,763	91,543
Merino, cross Tasmanian stock			2	2.75	2	2.007	.790	1/3.62	20,201	58,270
RUSSIA.										
Ewes, Merino	6	13 12	7	2.14	7	2.169	.854	1/3.70	25,656	84,457
Rams, Merino	1	19 4	1	2	1	2.083	.820	1/3.79	20,970	68,760
TURKEY.										
Ewes, fat-tail			6	6.66	6	4.229	1.655	1/2.55	32,273	95,295
Rams, fat-tail			4	8.87	4	4.379	1.724	1/2.54	28,933	47,990
Wethers, fat-tail			1	4	1	2.543	1.001	1/2.54	19,135	59,258
URUGUAY.										
Ewes:										
Merino	1	7 0	2	3.12	2	2.162	.851	1/2.54	20,520	62,300
Rambouillet-Merino	24	7 10	27	2.50	27	1.961	.772	1/2.54	25,308	82,500
German Merino	2	7 1	2	2.90	2	2.045	.805	1/2.54	23,299	72,245
Gilbert Merino	1	8 13	1	3	1	1.824	.718	1/2.54	21,951	85,951
Vermont, cross Gilbert Merino	1	7 3	1	2.40	1	1.938	.763	1/2.54	24,580	63,310
One-half Gilbert, Merino	1	10 4	1	2.50	1	2.040	.803	1/2.54	19,757	62,228
One-half Gilbert, cross one-half Steiger Merino	1	6 5	1	1.90	1	2.060	.811	1/2.54	22,083	56,931
One-half Vermont Merino	1	14 0	1	2.50	1	1.984	.781	1/2.54	23,850	66,344
One-half Vermont Merino	1	6 1	1	2.40	1	2.014	.793	1/2.54	20,692	96,817
Shropshire	1	9 11	1	4	1	4.242	1.670	1/2.54	27,121	70,081
Three-fourths Shropshire	1	11 0	1	2	1	1.908	.751	1/2.54	23,250	60,400
Lincoln	4	5 7	4	6.12	4	3.493	1.375	1/2.54	34,991	85,977
Lincoln cross	2	5 8	3	8.50	3	2.566	1.010	1/2.54	30,216	83,489
Rams:										
Merino	2	5 7	2	2.65	5	1.758	.692	1/2.54	22,590	75,362
Rambouillet-Merino	20	8 8	29	2.75	33	2.091	.8234	1/2.54	23,740	75,809
Vermont Merino	1	5 4	1	2.50	1	1.928	.757	1/2.54	19,299	77,197
One-half Vermont Merino	1	14 8	1	2.40	1	2.088	.822	1/2.54	24,572	77,201
Grade Vermont Merino	1	15 0	1	5.50	1	2.149	.846	1/2.54	28,490	83,306
Shropshire Down	1	8 12	1	3.50	1	3.010	1.185	1/2.54	28,522	89,608
Devon	1	7 0	1	5.50	1	3.747	1.475	1/2.54	25,254	32,036
Lincoln	5	10 2	7	7.43	7	3.292	1.296	1/2.54	35,557	94,383
Lincoln cross			1	4.25	1	2.215	.872	1/2.54	16,378	38,998
VICTORIA.										
Ewes:										
Merino	69	8 6	72	3.73	76	1.885	.742	1/2.54	26,158	80,431
Australian, cross Vermont Merino	9	8 10	9	2.98	9	1.958	.771	1/2.54	24,240	79,232
Rams:										
Merino	15	10 5	18	3.56	18	1.938	.763	1/2.54	23,490	67,689
Australian, cross Vermont Merino	4	17 0	4	3.20	4	2.261	.890	1/2.54	19,241	59,797
Wethers, Merino	1	8 12	1	4.50	1	1.836	.723	1/2.54	25,638	78,499
Lambs, Merino	1	2 14	2	2.50	2	1.735	.683	1/2.54	36,560	122,227

Averages of all measurements for each sex in the several breeds—Continued.

DOMESTIC WOOLS.

Breed and sex.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
ARIZONA.										
Ewes:		*Lbs. ozs.*								
Grade Merino	1	4 1	1	1	1	2.395	.943	1/1000	20,125	86,900
Shropshire	1	5 2	1	1.75	1	2.357	.928	1/1077	.....	.....
Rams, Shropshire	1	8 15	1	3.50	1	1.849	.728	1/1373	27,453	129,840
Wethers:										
Spanish Merino	1	10 1	1	1.30	1	1.994	.785	1/1273	22,062	79,208
Grade Merino	2	4 12	2	1	2	3.439	1.354	1/738	28,781	77,659
COLORADO.										
Ewes:										
Merino	2	18 4	1	2.50	2	2.342	.922	1/1084	26,972	87,577
Shropshire	5	11 3	5	5.80	5	3.307	1.302	1/767	28,882	81,125
Wethers:										
Native	1	7 8	1	4	1	2.571	1.012	1/987	41,782	95,241
Shropshire, cross range	3	9 14	3	2.90	4	2.913	1.147	1/871	33,845	89,947
ILLINOIS.										
Ewes:										
Merino	1	16 9	1	2	1	2.665	1.049	1/953	21,838	83,994
Oxford	1	3 9	1	2.05	1	2.611	1.028	1/973	28,391	95,992
Cotswold	2	8 11	2	5.60	2	3.284	1.293	1/773	42,369	133,612
Shropshire, cross Merino	1	2 7	1	3.34	1	2.482	.977	1/1023	32,457	109,714
Oxford, cross Cotswold, cross Merino	1	4 6	1	2.90	1	2.443	.962	1/1039	44,725	120,260
INDIANA.										
Ewes:										
Grade Merino	2	5 2	1	2	2	2.101	.827	1/1209	24,734	77,857
Southdown	7	6 1	7	3.77	7	3.152	1.241	1/806	22,149	61,748
Shropshire Down	12	9 3	13	4.42	14	3.371	1.327	1/753	26,161	88,892
Oxford Down	4	8 1	4	6.34	4	3.622	1.426	1/701	28,154	82,764
Cotswold	6	8 5	7	7.68	7	3.599	1.417	1/706	29,478	75,945
Rams:										
Grade Merino	2	12 9	2	3.25	3	1.786	.703	1/1421	17,544	60,936
Southdown	2	7 0	2	5.37	2	3.414	1.344	1/744	37,408	140,396
Shropshire Down	1	6 8	1	2	1	3.409	1.342	1/745	16,522	61,125
Oxford Down	2	9 0	1	5.25	2	4.176	1.644	1/608	20,100	56,095
Cotswold	3	12 0	3	8.04	3	3.429	1.350	1/740	32,803	80,080

IOWA.											
Ewes:											
National Delaine Merino	3	10	8	2	4.55	3	1.778	.700	1/2	30,447	73,761
American Merino	1	18	0	1	2.25	1	2.885	1.124	1/2	12,055	33,605
National Delaine and Spanish Merino	1	7	4	1	3.43	1	2.002	.788	1/2	19,545	63,137
Dickinson Delaine Merino	2	13	6	2	2.35	2	2.212	.871	1/2	31,493	99,645
Southdown	3	8	2	3	3.75	3	2.817	1.111	1/2	32,318	80,548
Shropshire Down	2	11	7	2	3.39	3	3.094	1.218	1/2	22,757	63,092
Hampshire Down	2	7	3	2	2.81	2	2.685	1.057	1/2	24,662	64,873
Rams:											
National Delaine Merino	3	12	0	3	2.80	4	2.479	.976	1/2	16,246	57,915
American Merino	1	21	13	1	2.08	1	2.332	.918	1/2	23,148	73,470
Shropshire Down	2	11	0	1	4	2	2.977	1.172	1/2	34,241	90,212
Dorset Horn	1	8	9	1	4.25	1	3.449	1.358	1/2	29,826	68,144
KENTUCKY.											
Ewes:											
Southdown	7	6	4	7	2.73	7	2.741	1.079	1/2	24,218	104,119
Oxford Down	2	9	9	2	4.55	2	3.066	1.207	1/2	34,920	106,875
Oxford and Southdown	1	7	14	1	3.28	1	3.046	1.199	1/2	19,713	103,250
Rams, Southdown	2	7	6	2	2.74	2	3.165	1.246	1/2	20,075	86,985
MICHIGAN.											
Ewes:											
Merino	6	19	2	4	2.21	6	2.129	.838	1/2	25,368	74,578
Spanish Merino	1	16	12			2	2.215	.872	1/2	25,842	85,679
Shropshire	2	14	2	2	3.84	3	4.128	1.625	1/2	26,075	71,288
Rams:											
Merino	2	28	0	2	2.62	2	2.101	.827	1/2	38,487	127,837
National Delaine Merino	1	12	8			1	2.184	.860	1/2	25,895	80,721
Shropshire	2	15	8	2	3.50	2	3.363	1.324	1/2	33,740	81,443
MINNESOTA.											
Ewes, Shropshire	8	6	9	5	3.69	8	3.023	1.190	1/2	23,747	73,431
MISSOURI.											
Ewes:											
Merino	2	17	9	1	2.80	2	2.040	.803	1/2	22,051	78,827
Spanish Merino	2	15	0	2	2.21	2	1.849	.728	1/2	26,391	78,173
Delaine Merino	5	17	8	5	2.60	5	2.108	.830	1/2	23,042	75,008
Southdown, cross Merino	1	6	15	1	2.37	1	2.515	.990	1/2	15,460	45,645
Rams:											
Merino	7	22	9	6	2.58	7	2.456	.967	1/2	25,185	74,013
Spanish Merino	3	19	0	3	2.41	3	2.350	.925	1/2	19,248	57,171
Delaine Merino	1	19	15	1	3	1	2.213	.871	1/2	24,889	67,123
Southdown	1	4	13	1	2.31	1	2.748	1.082	1/2	18,287	89,527
Shropshire Down	1	5	13	1	3.25	1	3.528	1.389	1/2	13,724	42,462
MONTANA.											
Ewes:											
Grade Merino	4	6	5	4	3.12	4	2.167	.853	1/2	21,550	69,497
Cotswold	1	9	6	1	2.50	1	2.260	.890	1/2	23,407	66,180

Averages of all measurements for each sex in the several breeds—Continued.

DOMESTIC WOOLS—Continued.

Breed and sex.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
MONTANA—continued.										
Rams:		*Lbs. ozs.*								
Delaine Merino	1	21 8	1	2	1	2.210	.870	7/8	17,611	60,397
Spanish and Delaine Merino	1	12 2	1	2.76	1	2.212	.871	7/8	31,784	82,835
Southdown	1	4 0	.....	.....	1	2.345	.923	15/16	23,542	77,325
Wethers:										
Oxford	1	14 0	1	3.25	1	2.401	.945	15/16	22,799	73,263
Grade Merino	6	10 4	6	2.65	6	1.941	.764	3/4	29,546	100,020
Grade Spanish Merino	1	13 0	1	3.25	1	1.816	.715	11/16	29,602	107,640
Shropshire Down grade	1	8 2	1	3.50	1	1.948	.765	3/4	21,465	77,745
NEW YORK.										
Ewes:										
Merino	6	11 7	6	2.54	6	2.004	.789	13/16	24,337	65,587
American Merino	2	16 0	2	2.37	2	1.984	.781	13/16	29,608	87,258
Rambouillet-Merino	2	14 0	1	2.70	2	2.055	.809	13/16	28,181	64,138
Southdown	2	7 0	2	4.12	2	3.134	1.234	1 1/4	15,555	48,723
Shropshire Down	2	7 8	2	3.87	2	2.824	1.112	1 1/8	27,230	105,795
Oxford Down	2	10 10	2	5.12	2	3.571	1.406	1 7/16	27,340	84,335
Hampshire Down	2	7 9	2	4	2	2.817	1.109	1 1/8	29,808	86,581
Cheviot	2	7 1	2	7	2	3.239	1.275	1 5/16	30,300	88,628
Dorset Horn	2	6 2	2	4	2	3.231	1.272	1 5/16	30,660	49,148
Cotswold	2	12 12	2	14.50	2	4.663	1.836	1 7/8	21,689	53,042
Rams:										
Merino	6	20 14	4	2.25	6	2.316	.912	15/16	18,406	66,582
American Merino	2	20 10	.....	.....	2	1.994	.785	13/16	28,009	84,821
Rambouillet-Merino	2	10 10	2	2.21	2	1.651	.650	11/16	36,255	154,809
Southdown	2	7 0	2	3.62	2	2.817	1.109	1 1/8	16,305	44,300
Shropshire Down	2	8 0	2	3.87	2	3.246	1.278	1 5/16	25,013	97,190
Oxford Down	2	10 9	2	5.12	2	3.383	1.332	1 3/8	31,067	78,824
Hampshire Down	2	8 4	2	4	2	2.852	1.123	1 1/8	26,487	67,972
Cheviot	3	11 7	3	5.83	3	3.510	1.382	1 7/16	34,524	70,456
Dorset Horn	2	7 0	2	4	2	3.122	1.229	1 1/4	21,694	62,555
Cotswold	2	16 9	2	9.37	2	3.808	1.499	1 1/2	29,169	77,767
NORTH CAROLINA.										
Sex not given:										
Southdown	.....	.....	5	4.30	5	2.736	1.077	1 1/8	36,847	106,482
Oxford Down	.....	.....	3	5.33	3	3.043	1.198	1 3/16	31,148	96,576
Worcester	.....	.....	4	5	4	2.895	1.140	1 1/8	44 203	106,294

OHIO.											
Ewes:											
Merino	30	10	10	31	2.45	31	2.131	.839	1/1101	24,614	72,025
American Merino	13	13	2	14	3.12	14	2.289	.901	1/1109	22,980	68,365
Delaine Merino	28	9	5	28	3.13	28	2.167	.853	1/1171	23,421	77,512
Spanish Merino	12	11	1	12	2.58	12	2.164	.852	1/1173	22,797	68,069
Black-top Merino	7	7	10	7	2.38	7	2.006	.7898	1/1266	25,276	70,132
Welles and Dickinson Merino	1	5	12	1	3	1	1.824	.718	1/1393	25,202	75,139
Rambouillet-Merino	3	11	5	3	2.75	3	2.192	.863	1/1158	20,057	58,821
Black-top and National Delaine Merino	3	8	11	3	2.69	3	2.278	.897	1/1134	20,286	66,099
Dickinson and Delaine Merino	1	9	13	1	2.11	1	2.271	.894	1/1118	18,345	54,848
Atwood and Dickinson Merino	1	12	1	1	3.08	1	1.946	.766	1/1303	24,426	82,350
Black-top and Spanish Merino	3	11	1	3	3.59	3	1.933	.761	1/1313	30,112	80,649
National Delaine and Dickinson Merino	5	12	4	5	2.23	5	2.035	.801	1/1248	23,117	70,234
Grade Merino	2	5	13	2	3	2	2.550	.925	1/1080	18,476	56,959
Grade black-top Merino	1	5	15	1	3.50	2	1.930	.760	1/1315	25,534	71,568
Southdown	3	4	6	2	3.06	3	2.814	1.108	1/902	25,211	42,158
Shropshire Down	15	8	7	14	3.33	15	3.391	1.335	1/736	31,064	84,139
Oxford Down	5	9	1	5	5.14	5	3.693	1.454	1/677	30,429	54,978
Cotswold	9	11	12	9	6.59	9	4.077	1.605	1/612	33,336	76,938
Cotswold, cross Leicester	1	9	11	1	7	1	3.149	1.240	1/806	38,588	85,280
Rams:											
Merino	15	14	9	15	2.71	15	2.169	.854	1/1170	22,024	71,289
American Merino	6	18	1	6	2.08	6	2.210	.870	1/1149	24,170	88,450
Delaine Merino	24	10	70	23	3.92	24	2.141	.843	1/1186	23,624	70,226
Black-top Merino	3	8	4	3	2.51	3	2.101	.827	1/1108	22,619	65,470
Black-top and National Delaine Merino	1	13	7	1	3.95	1	1.890	.744	1/1273	28,558	69,515
National Delaine and Dickinson Merino	3	2	2	3	3.22	3	1.923	.757	1/1200	27,072	91,123
Shropshire Down	4	10	6	4	4.14	5	3.429	1.350	1/740	26,989	68,122
Oxford Down	2	10	3	2	5.50	2	3.688	1.452	1/688	34,373	84,539
Cotswold	2	15	1	2	6.95	2	4.079	1.606	1/611	30,715	65,007
Cotswold and Leicester	2	8	10	2	5.70	2	3.124	1.230	1/813	28,746	69,244
Shropshire Down and Leicester	2	9	15	2	5.91	2	3.216	1.266	1/789	31,430	79,741
Wethers:											
Merino	5	10	1	5	3.33	5	2.667	1.050	1/952	22,605	61,855
Spanish Merino	2	12	5	2	3.33	2	2.108	.830	1/1204	31,549	92,311
Rambouillet-Merino	1	16	5	1	4.35	1	1.864	.734	1/1362	26,492	72,582
Cotswold	2	9	0	1	12.50	2	3.414	1.344	1/743	38,553	79,288
PENNSYLVANIA.											
Ewes:											
Merino	4	13	4	3	3.02	4	2.096	.825	1/1211	25,430	77,338
Delaine Merino	5	10	12	5	3.05	5	2.189	.862	1/1160	22,470	63,400
Grade Merino	1	9	8	1	2.25	1	2.162	.851	1/1174	20,388	61,635
Rams:											
Merino	3	13	0	3	3.42	3	2.174	.856	1/1168	16,909	43,129
Delaine Merino	9	13	9	9	3.09	9	2.083	.820	1/1179	22,379	65,693
SOUTH DAKOTA.											
Ewes:											
Spanish Merino	1	8	3			1	1.885	.742	1/1347	36,825	129,210
French Merino	1	3	7	1	2.50	1	1.897	.747	1/1338	55,167	173,950
Oxford Down	2	13	5	1	6	1	3.010	1.185	1/825	26,977	91,656

Averages of all measurements for each sex in the several breeds—Continued.

DOMESTIC WOOLS—Continued.

Breed and sex	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters	Thousandths of inch	Fractions of inch.		
SOUTH DAKOTA—continued.										
Ewes—continued.		*Lbs. ozs.*								
One-half Shropshire Down, cross one-half Merino	5	5 12	3	2.80	5	2.817	1.110	9/81	26,259	91,910
Three-fourths Shropshire Down, cross one-fourth Merino	3	11 0	2	4.50	3	1.854	.730	13/69	33,026	115,729
Seven-eighths Shropshire Down, cross one-eighth Merino	1	5 9	1	3.60	1	2.316	.912	10/88	33,395	107,550
Shropshire, cross Merino	6	11 8	5	3.26	6	3.457	1.361	7/14	26,002	89.747
One-half Merino, cross one-half Southdown	1	19 13	1	7.98	1	2.124	.836	11/28	40,040	119,990
One-half Merino, cross one-half Cotswold	1	6 9	.....	.....	1	2.260	.890	11/28	27,482	89,255
Three-fourths Merino, cross one-fourth Cotswold	1	12 15	1	2.57	1	2.307	.908	11/28	22,994	79,538
Three-fourths Cotswold	1	3 11	1	3	1	2.614	1.029	9/71	30,718	111,039
Three-fourths Merino, cross one-fourth Lincoln	1	6 9	1	1.28	1	2.185	.860	11/28	30,755	121,225
One-half Shropshire, cross one-half Cotswold	1	4 0	1	4.11	1	2.167	.853	11/71	53,998	144,160
One-fourth Shropshire, cross three-fourths Cotswold	1	3 5	1	3.60	1	2.631	1.036	9/28	35,222	168,460
Three-fourths Shropshire, cross one-fourth native	1	8 7	1	3.25	1	2.403	.946	10/28	45,880	157,990
Rams:										
Dickinson and Delaine Merino	1	20 2	1	2.57	1	2.141	.843	11/28	24,394	141,210
Oxford Down	1	15 10	1	6	1	3.897	1.534	8/71	19,845	55,763
Dorset Horn	1	5 6	1	.....	1	2.545	1.002	9/87	28,191	76,898
Shropshire, cross Merino	3	8 3	3	4.62	3	2.776	1.093	9/74	42,420	142,049
UTAH.										
Ewes:										
French Merino	.....	.....	2	3.07	2	1.964	.773	13/63	20,991	78,775
French Merino, cross Cotswold	.....	.....	1	2.79	1	6.769	2.665	3/74	42,583	123,144
Rams, Shropshire Down	.....	.....	.....	.....	1	3.797	1.495	6/28	25,711	80,580
VERMONT.										
Ewes:										
Vermont Merino	10	22 5	10	3.05	12	2.014	.793	13/61	26,224	80,092
American Merino	1	17 0	1	1.94	1	2.565	1.010	9/90	37,885	105,120
Rams:										
Vermont Merino	3	17 3	3	1.82	4	2.497	.983	10/17	16,909	68,451
American Merino	1	27 3	1	2.25	1	2.454	.966	10/28	57,164	166,900
WEST VIRGINIA.										
Ewes:										
Merino	1	7 14	1	2.50	1	.....	.727	.....	33,086	88,728
Spanish Merino	2	8 2	1	2.75	1	2.179	.858	11/28	25,090	72,782
Saxony Merino	1	2 9	1	1.25	1	1.374	.541	10/28	31.700	121,100

Rams:											
Merino	1	10	4	.....	.....	1	2.027	.798	1/1252	22,733	77,507
Delaine Merino	1	7	12	1	2.50	1	2.055	.809	1/1238	21,151	72,540
Black-top Spanish Merino	1	5	12	1	3.50	1	2.182	.859	1/1163	22,535	66,951
WISCONSIN.											
Ewes:											
Merino	.....	.....		2	3.18	1	2.098	.826	1/1210	28,622	.....
Delaine Merino	3	15	11	3	2.98	3	2.418	.952	1/1050	21,307	60,137
Spanish Merino	19	15	6	19	2.12	19	2.276	.896	1/1115	23,972	72,969
Southdown	7	9	2	8	3.80	8	3.005	1.183	1/848	27,360	87,236
Shorpshire Down	9	9	13	9	3.80	11	3.604	1.419	1/704	24,287	66,738
Oxford Down	8	10	5	8	5.04	8	3.711	1.461	1/684	26,640	73,119
Hampshire Down	6	8	7	6	3.02	6	3.744	1.474	1/678	22,541	70,430
Dorset Horn	3	6	5	3	4.11	3	3.127	1.231	1/812	25,365	75,854
Lincoln	4	10	0	3	7.50	4	3.472	1.367	1/731	33,073	79,206
Cotswold	7	13	3	8	8.80	8	3.721	1.465	1/682	41,332	157,961
First-cross Shropshire	6	10	15	6	2.94	6	2.753	1.084	1/922	23,333	70,681
Second-cross Shropshire	6	7	5	6	2.89	6	3.046	1.199	1/833	21,098	63,968
First-cross Oxford-Merino	5	7	6	5	2.51	5	2.819	1.099	1/900	22,283	65,078
Second-cross Oxford-Merino	8	6	9	8	3.68	8	3.226	1.270	1/787	25,923	82,605
Shropshire cross	1	13	0	1	2.76	1	2.972	1.170	1/684	16,558	60,400
Rams:											
Delaine Merino	4	19	6	4	3.23	4	2.291	.902	1/1106	20,413	61,048
Spanish Merino	9	18	15	10	2.49	10	2.177	.857	1/1166	27,898	86,280
Southdown	4	9	6	4	3.62	4	3.028	1.192	1/838	23,642	79,663
Shropshire Down	6	12	11	7	4.87	7	3.630	1.429	1/699	28,952	82,718
Oxford Down	4	13	10	5	5.27	5	3.176	1.250	1/799	32,980	91,250
Hampshire Down	2	6	8	2	2.89	2	2.921	1.150	1/869	25,321	94,429
Lincoln	2	13	0	2	5.47	2	3.777	1.487	1/673	28,353	71,544
Cotswold	3	15	2	3	10.68	3	3.835	1.510	1/662	36,733	91,057
WYOMING.											
Ewes:											
Merino	1	17	4	.....	.....	1	2.086	.821	1/1217	49,274	133,160
French Merino	1	14	14	1	2.75	1	2.997	1.118	1/847	16,819	60,874
Grade Merino	11	13	0	11	2.61	12	2.182	.859	1/1163	22,105	70,321
Rams, grade Merino	2	12	12	2	3.25	2	1.869	.736	1/1358	21,894	84,894
Wethers:											
Grade Merino	12	13	5	12	2.43	12	2.009	.791	1/1264	25,568	75,117
Shropshire Down	1	17	13	1	2.75	1	2.748	1.082	1/924	39,034	116,243

The difficulties to be met in the comparisons to be made in such tables are many and manifest. The most important is the great inequality in the number of samples offered in each class. Thus, it would be very interesting to compare the results for fleeces in the same class but from animals of different ages, but on this account it was almost impracticable. So, also, absolute comparison of ewes' fleeces with rams' fleeces is extremely difficult, because from many of the countries we have large numbers of samples from one sex and a small number from the other. Thus, from the Argentine Republic we have a large number of ewes' fleeces and a very small number of rams' fleeces. As a fact, excepting for 8 fleeces of Lincoln and 1 fleece of Negretti Merino, the collection was wanting in rams' fleeces. The same relation is found in the collection from Cape Colony. In the class of Merinos we have 52 ewes, 34 wethers, and only 10 rams. This fact shows the popular knowledge of what our tables, in spite of the disproportion mentioned, also corroborate, that except in the matter of the weight of the fleece, the ewes' fleeces are better than the rams' fleeces. Let us illustrate this by some abstracts from the tables and bring together general averages for the Merino ewes and rams from those countries from which a sufficient number of each sex was offered.

Country or State.	Number of samples.	Average weight of fleece.	Number of samples.	Fineness.	Ultimate strength.	Modulus of elasticity.
Ewes:		*Lbs. ozs.*				
Cape Colony	70	7 2.5	70	.7237	28,285	86,562
New South Wales	112	10 6.5	115	.7531	25,760	83,688
Victoria	78	8 7.6	85	.7455	25,995	80,304
Uruguay	24	7 10	27	.7720	25,308	82,500
Ohio	88	10 7.25	90	.8391	24,084	69,374
New York	10	13 1.4	10	.7920	25,165	69,601
Rams:						
Cape Colony	10	9 0	9	.7414	27,117	91,193
New South Wales	52	15 7	57	.7889	23,368	75,230
Victoria	19	11 11.7	22	.7867	22,709	66,254
Uruguay	20	8 8	33	.8234	23,740	75,809
Ohio	56	12 2.68	56	.8452	23,125	67,514
New York	10	18 8	10	.8346	23,896	87,875

These examples might be extended, but they are quite sufficient to establish the fact. There will, of course, be individual exceptions, and we find such in the records for Ohio. Thirteen American Merino ewes' fleeces have an average of 0.901 inch, while 6 rams' fleeces of the same breed or strain have fineness of 0.870 inch; 28 Delaine Merino ewes have fineness corresponding with 0.853 inch, while the 24 rams in that class have fineness of 0.843 inch. Yet, notwithstanding these exceptions, the preponderance of evidence is in favor of the general rule that, while the rams' fleeces are heavier, they are inferior to the ewes' fleeces in fineness, strength, and elasticity, and upon the whole are of lower quality for manufacturing purposes.

If now we pass to the comparison of the general averages of all results for the different breeds and crosses, irrespective of sex, age, or other conditions, from the several countries and States represented in the Exposition, we find further interesting relations. The following table exhibits a compilation of such general averages for each country. No attempt has been made to make a general average for each State or wool district in the foreign countries, for we are scarcely sufficiently familiar with the divisions to do it properly. However, the figures offered will serve the purpose in view. The foreign countries and the different States of our own country are respectively arranged in alphabetical order, and the breeds and crosses are placed in as nearly as possible the same order for convenience in comparison.

General averages of all measurements for each breed from different countries and the United States.

FOREIGN WOOLS.

Breed.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
ARGENTINE REPUBLIC.		*Lbs. ozs.*								
Merino	33	7 4	38	2.70	39	2.184	0.860	1/[illegible]	22,096	68,619
Lincoln	22	8 11	22	7.79	22	3.589	1.413	1/[illegible]	37,081	119,172
Grade Merino	124	5 13	125	2.65	125	2.126	.837	1/[illegible]	21,944	70,659
Merino cross	2	4 1	2	3.25	2	2.288	.899	1/[illegible]	31,730	88,042
Merino cross, Southdown	2	7 3	2	7.50	2	1.915	.754	1/[illegible]	21,429	74,775
Lincoln cross	61	6 14	62	5.05	62	2.891	1.138	1/[illegible]	35,545	89,146
Lincoln second cross	2	5 0	2	3.25	2	3.457	1.361	1/[illegible]	18,245	62,282
CAPE COLONY.										
Merino	121	7 1	121	3.09	123	1.881	.7405	1/[illegible]	27,617	87,197
NEW SOUTH WALES.										
Merino	173	11 6	173	4.50	178	1.9495	.7675	1/[illegible]	25,582	80,516
Lincoln	5	14 3	4	10.50	5	3.571	1.466	1/[illegible]	43,115	97,554
Leicester	6	10 14	6	5.70	6	3.617	1.424	1/[illegible]	30,708	90,693
Lincoln, cross Merino	5	12 7	5	3.39	5	2.921	1.150	1/[illegible]	29,064	88,655
NEW ZEALAND.										
Merino			15	4.276	17	2.148	.8454	1/[illegible]	28,056	92,196
RUSSIA.										
Merino	7	14 9	8	2.12	8	2.159	.850	1/[illegible]	25,070	82,495
SPAIN.										
Merino	7	5 6	9	2.74	9	2.230	.878	1/[illegible]	20,059	76,675
TURKEY.										
Fat-tail			11	7.23	11	4.115	1.620	1/[illegible]	10,191	59,108
URUGUAY.										
Merino	59	8 5	75	2.67	77		.7969		24,180	77,789
Shropshire	2	9 3	2	3.75	2	3.626	1.4275	1/[illegible]	27,821	79,848
Lincoln	9	9 0	11	6.95	11	3.386	1.333	1/[illegible]	35,335	91,334
Lincoln cross	2	12 7	5	2.55	5	1.961	.780	1/[illegible]	21,405	59,893
Devon	1	7 0	1	5.50	1	3.747	1.475	1/[illegible]	20,254	32,086
VICTORIA.										
Merino	99	9 0	106	3.52	110	1.911	.7524	1/[illegible]	25,498	84,694

ARIZONA.										
Spanish Merino	1	10 1	1	1.30	1	1.994	.785	1/3 1/5	22,062	79,208
Grade Merino	3	4 8	3	1	3	3.091	1.217	1/3	19,229	80,739
Shropshire	1	8 15	1	3.50	1	1.849	.728	1/3 1/3	27,458	120,840
COLORADO.										
Merino	2	18 4	1	2.50	2	2.342	.922	1/3 1/4	26,972	87,517
Shropshire Down	5	11 3	5	5.80	3	3.307	1.302	1/3	28,882	81,125
Shropshire Down, cross range	3	9 14	3	2.91	5	2.913	1.147	1/3 1/3	33,845	89,947
Native	1	7 8	1	4	1	2.570	1.012	1/3 1/3	41,782	95,241
ILLINOIS.										
Merino	1	16 9	1	2	1	2.664	1.049	1/3 1/3	21,838	83,994
Cotswold	2	8 11	2	5.56	2	3.284	1.293	1/3 1/3	42,369	133,612
Shropshire, cross Merino	1	2 7	1	3.34	1	2.482	.977	1/3 1/3	82,457	109,714
Oxford, cross Merino	1	3 9	1	2.05	1	2.611	1.028	1/3 1/3	28,391	95,992
Oxford, cross Cotswold, cross Merino	1	4 6	1	2.91	1	2.433	.962	1/3 1/3	44,725	120,260
INDIANA.										
Grade Merino	4	8 14	3	2.50	5	2.268	.893	1/3 1/3	20,400	67,704
Southdown	9	6 13	9	4.12	9	3.211	1.264	1/3 1/3	25,540	79,225
Shropshire Down	13	9 1	14	4.25	15	3.373	1.328	1/3 1/3	24,852	82,374
Oxford Down	6	9 2	5	6.12	6	3.805	1.498	1/3 1/3	25,469	73,874
IOWA.										
Merino	11	11 9	11	2.70	12	2.065	.813	1/3 1/3	20,079	57,428
Southdown	8	8 2	8	3.75	8	2.822	1.111	1/3 1/3	32,318	80,548
Shropshire Down	4	12 1	3	3.59	5	3.048	1.200	1/3 1/3	27,351	73,940
Hampshire Down	2	7 3	2	2.80	2	2.685	1.057	1/3 1/3	24,662	64,873
Dorset Horn	1	8 9	1	4.25	1	3.437	1.353	1/3 1/3	29,826	68,144
KENTUCKY.										
Southdown	9	6 10	9	2.73	9	2.835	1.116	1/3 1/3	23,308	100,312
Oxford Down	2	9 9	2	4.55	2	3.066	1.207	1/3 1/3	34,920	106,875
Oxford, cross Southdown	1	7 14	1	3.28	1	3.045	1.199	1/3 1/3	19,713	108,250
MICHIGAN.										
Merino	10	20 2	6	2.35	11	2.144	.844	1/3 1/3	27,887	89,566
Shropshire Down	4	14 12	4	3.69	5	3.823	1.505	1/3 1/3	29,141	75,320
MINNESOTA.										
Shropshire Down	8	6 9	5	3.69	8	3.020	1.190	1/3 1/3	23,747	78,431
MISSOURI.										
Merino	20	19 10	18	2.11	20	2.250	.886	1/3 1/3	23,606	72,288
Southdown	1	4 13	1	2.31	1	2.748	1.082	1/3 1/3	18,237	89,527
Shropshire Down	1	5 13	1	3.25	1	.....	1.389	.....	13,724	42,462
Southdown, cross Merino	1	6 15	1	2.37	1	2.515	.990	1/3 1/3	15,460	45,645

General average of all measurements for each breed from different countries and the United States—Continued.

DOMESTIC WOOLS—Continued.

Breed.	Fleece.		Length of staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
MONTANA.		*Lbs. ozs.*								
Grade Merino	13	10 5	13	2.79	13	2.042	.804	1/1243	26,344	86,845
Southdown	1	4 0			1	2.344	.923	1/1083	23,542	77,325
Oxford Down	1	14 0	1	3.25	1	2.400	.945	1/1058	22,799	73,263
Cotswold	1	9 6	1	2.50	1	2.261	.890	1/1123	23,407	66,180
Grade Shropshire	1	8 2	1	3.50	1	1.943	.765	1/1307	21,465	77,745
NEW YORK.										
Merino	20	15 15	15	2.40	20	2.073	.816	1/1225	24,580	78,738
Southdown	4	7 0	4	3.87	4	3.528	1.169	1/856	15,980	44,011
Shropshire Down	4	7 2	4	3.87	4	2.916	1.148	1/871	26,122	101,492
Oxford Down	4	10 9	4	5.12	4	3.478	1.369	1/730	29,203	81,329
Hampshire Down	4	8 1	4	4	4	2.835	1.116	1/896	26,145	77,277
Cheviot	5	9 11	5	6.30	5	3.401	1.339	1/746	32,834	77,725
Dorset Horn	4	6 7	4	4	4	3.048	1.200	1/833	26,177	55,852
Cotswold	4	4 11	4	11.92	4	4.237	1.668	1/599	22,279	65,404
NORTH CAROLINA.										
Southdown			5	4.30	5	2.787	1.0774	1/928	36,848	108,485
Oxford Down			3	5.50	3	3.042	1.1977	1/835	31,147	98,906
Worcester			4	5.237	4	2.896	1.1400	1/877	33,152	106,294
OHIO.										
Merino	168	11 2	164	3.11	165	2.294	.903	1/1107	24,871	78,960
Southdown	3	4 6	3	2.60	3	2.815	1.108	1/902	25,211	42,157
Shropshire Down	20	10 9	20	3.16	20	3.401	1.339	1/746	30,045	80,134
Oxford Down	7	9 10	7	5.24	7	3.691	1.453	1/688	31,556	63,424
Cotswold	11	12 6	11	6	11	3.706	1.459	1/685	30,067	68,859
Grade Merino	2	5 13	2	3.08	2	2.350	.925	1/1080	18,746	56,959
Cotswold, cross Leicester	3	9 0	3	6.13	3	3.152	1.233	1/810	32,026	74,589
Shropshire, cross Leicester	2	9 15	2	5.91	2	3.216	1.266	1/789	31,430	79,741
PENNSYLVANIA.										
Merino	21	13 0	20	3.12	21	2.124	.836	1/1196	22,200	63,889
Grade Merino	1	9 8	1	2.25	1	2.162	.851	1/1174	20,388	61,635

SOUTH DAKOTA.											
Merino	3	10	9	2	2.53	3	1.974	.777	1/4 blood	38,795	122,715
Oxford Down	3	14	4	2	3	3	3.305	1.301	7/8 blood	24,589	79,692
Dorset Horn	1	5	6	.....	.....	1	2.545	1.002	3/4 blood	28,191	76,890
Shropshire Down, cross Merino	9	11	8	8	3.78	9	3.231	1.272	7/8 blood	20,364	107,181
One-half Shropshire, one-half Merino	5	5	12	3	2.80	5	2.819	1.110	1/2 blood	26,259	91,910
Three-fourths Shropshire, one-fourth Merino	3	11	0	2	4.50	3	1.854	.730	1/2 blood	33,026	115,729
Seven-eighths Shropshire, one-eighth Merino	1	5	9	1	3.60	1	2.317	.912	1/8 blood	33,390	107,550
One-half Merino, one-half Cotswold	1	6	9	.....	.....	1	2.261	.890	1/2 blood	27,482	89,255
Three-fourths Merino, one-fourth Cotswold	1	12	15	1	2.57	1	2.307	.908	1/4 blood	22,994	79,538
Three-fourths Cotswold	1	3	11	1	3	1	2.614	1.029	3/4 blood	30,769	111,039
Three-fourths Merino, cross Lincoln	1	6	9	1	1.28	1	2.184	.860	1/4 blood	30,755	121,225
One-half Merino, one-half Southdown	1	19	13	1	1.89	1	2.124	.836	1/2 blood	40,040	119,990
One-half Cotswold, one-half Shropshire Down	1	4	0	1	4.11	1	2.167	.853	1/2 blood	53,998	144,160
Three-fourths Cotswold, one-fourth Shropshire Down	1	3	5	1	3.60	1	2.631	1.036	3/4 blood	35,222	168,460
Three-fourths Shropshire, one-fourth native	1	8	7	1	3.25	1	2.403	.946	1/4 blood	45,880	157,990
UTAH.											
French Merino	.....	.....		2	3.07	2	1.963	.773	1/4 blood	20,991	78,775
French Merino, cross Cotswold	.....	.....		1	2.79	1	2.665	1.049	3/4 blood	42,583	123,144
Shropshire	.....	.....		.....	.....	1	3.797	1.495	Full blood	25,711	80,580
VERMONT.											
Merino	15	22	7	15	2.67	15	2.611	1.028	Full blood	31,158	100,462
WEST VIRGINIA.											
Merino	7	7	3	6	2.08	7	1.976	.778	1/4 blood	25,914	81,913
WISCONSIN.											
Merino	36	16	5	37	2.53	37	2.307	.908	1/4 blood	24,980	95,742
Southdown	11	9	3	12	3.74	12	3.012	1.186	Full blood	26,121	84,712
Shropshire Down	15	10	11	16	4.25	18	3.614	1.423	7/8 blood	26,098	72,951
Oxford Down	12	11	6	13	5.13	13	3.505	1.380	7/8 blood	29,086	80,093
Hampshire Down	8	8	0	8	2.89	8	3.538	1.393	7/8 blood	23,236	76,430
Cotswold	10	13	12	11	9.31	11	3.754	1.478	Full blood	40,078	117,805
Lincoln	6	11	7	6	5.61	6	3.574	1.407	7/8 blood	31,499	76,719
Grade Dorset Horn	3	6	5	3	4.11	3	3.127	1.231	3/4 blood	25,365	75,854
Shropshire cross	1	13	0	1	2.76	1	2.972	1.170	3/4 blood	16,558	60,400
First cross Shropshire	6	10	15	6	2.94	6	2.815	1.084	3/4 blood	23,333	70,681
Second cross Shropshire	6	7	5	6	2.89	6	3.046	1.199	Full blood	21,098	63,968
First cross Oxford-Merino	5	7	6	5	2.51	5	2.768	1.090	3/4 blood	22,283	65,078
Second cross Oxford-Merino	8	6	9	8	3.68	8	3.226	1.270	7/8 blood	25,923	82,605
WYOMING.											
Merino	4	14	6	3	3.08	4	2.164	.852	1/4 blood	27,470	90,955
Shropshire	1	17	13	1	2.75	1	2.748	1.082	Full blood	39,084	116,243
Grade Merino	24	12	10	24	2.41	24	2.096	.825	1/4 blood	22,170	72,715

General averages of all measurements for each breed from different countries and the United States.—Continued.

DOMESTIC WOOLS—Continued.

Breed.	Fleece.		Length of Staple.		Fineness.				Ultimate strength (pounds per square inch cross section).	Modulus of elasticity.
	Number of samples.	Weight.	Number of samples.	Inches.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.		
UNITED STATES.		*Lbs. oz.*								
Merino	295	13 14	303	2.85	321	2.253	.887	1/1127	25,667	84,271
Southdown	41	7 3	41	3.63	42	2.962	1.166	1/857	24,551	80,974
Shropshire Down	77	9 8	75	3.85	85	3.356	1.321	1/757	27,037	79,745
Oxford Down	35	10 11	34	5.12	36	3.515	1.384	1/723	28,751	79,604
Hampshire Down	14	8 5	14	3.05	14	3.480	1.137	1/716	24,241	77,725
Cheviot	5	9 11	5	6.30	5	3.401	1.339	1/748	32,834	76,719
Dorset Horn	6	6 9	5	4.05	6	3.028	1.192	1/838	27,120	75,021
Cotswold	37	11 7	39	7.24	39	3.589	1.413	1/707	31,593	74,671
Lincoln	6	11 7	6	5.61	6	3.574	1.407	1/710	31,499	61,408
Native	1	7 8	1	4	1	2.565	1.010	1/990	41,782	96,241
Grade Merino	23	8 14	22	2.50	24	2.250	.886	1/1128	22,899	76,053
Southdown, cross Merino	1	6 15	1	2.37	1	2.515	.990	1/1009	15,460	45,645
One-half Merino, cross one-half Southdown	1	19 13	1	7.89	1	2.123	.836	1/1196	40,040	119,990
Shropshire, cross Merino	10	10 9	9	3.72	10	3.155	1.242	1/805	21,573	107,434
Grade Shropshire	1	8 2	1	3.50	1	1.930	.760	1/1316	21,465	77,745
One-half Shropshire, one-half Merino	5	5 12	3	2.80	5	2.819	1.110	1/901	26,259	91,910
Three-fourths Shropshire, one-fourth Merino	3	11 0	2	4.50	3	1.854	.730	1/1369	33,026	115,729
First cross Shropshire	6	10 15	6	2.94	6	2.815	1.084	1/923	23,333	70,681
Second cross Shropshire	6	7 5	6	2.89	6	2.845	1.199	1/834	21,098	63,968
Seven-eighths Shropshire, one-eighth Merino	1	5 9	1	3.60	1	2.316	.912	1/1096	33,390	107,550
Shropshire cross	1	13 0	1	2.76	1	2.837	1.170	1/855	16,558	60,400
Oxford-Merino cross	1	3 9	1	2.05	1	2.611	1.028	1/973	28,391	96,992
First cross Oxford-Merino	5	7 6	5	2.51	5	2.769	1.090	1/917	22,283	65,078
Second cross Oxford-Merino	8	6 9	8	3.68	8	3.226	1.270	1/787	25,923	82,605
Oxford, cross Cotswold, cross Merino	1	4 6	1	2.91	1	2.443	.962	1/1039	44,725	120,260
Oxford, cross Southdown	1	7 14	1	3.28	1	2.845	1.199	1/834	19,718	103,250
One-half Cotswold, one-half Merino	1	6 9	.....	.....	1	2.261	.890	1/1124	27,482	89,255
One-fourth Cotswold, three-fourths Merino	1	12 15	1	2.57	1	2.0365	.908	1/1101	22,994	79,538
Three-fourths Cotswold	1	3 11	1	3	1	2.614	1.029	1/972	30,769	111,039
One-half Cotswold, one-half Shropshire	1	4 0	1	4.11	1	2.167	.853	1/1171	53,998	144,160
Three-fourths Cotswold, one-fourth Shropshire	1	3 5	1	3.60	1	2.631	1.036	1/965	35,222	168,460
Cotswold, cross Leicester	3	9 0	3	6.18	3	3.132	1.233	1/811	32,026	74,589
Three-fourths Merino, cross Lincoln	1	6 9	1	1.28	1	2.185	.860	1/1163	30,755	121,225
Grade Dorset Horn	3	6 5	3	4.11	3	3.127	1.231	1/812	25,365	75,854
Shropshire, cross Leicester	2	9 15	2	5.91	2	3.216	1.266	1/789	31,430	79,741
Three-fourths Shropshire, one-fourth native	1	8 7	1	3.25	1	2.403	.946	1/1057	45,890	157,990
Shropshire range	3	9 14	3	2.91	3	2.913	1.147	1/871	33,845	89,947

In every exhibition, whether local or international, the interest of wool men naturally centers in the fine wools first of all. The Merino breeds and their crosses produce the larger proportion of the wools sent to the markets, and for manufacturing purposes are most sought after. The coarse wools are merely secondary products. The animals producing them are grown principally for mutton, and the carcass is the most precious portion. Let us then, for the sake of comparison, bring together the figures showing the qualities of the staple in the fine wools, Merino and its crosses, from the different countries.

Country.	Number of samples.	Weight of fleece.	Number of samples.	Length of staple.	Number of samples.	Fineness.	Ultimate strength (per square inch of cross section).	Modulus of elasticity.
		Lbs. ozs.		*Inches.*		*Inch.*	*Pounds.*	
Argentina	33	7 4	38	2.70	39	.860	22,096	68,619
Cape Colony	121	7 1	121	3.09	123	.7405	27,617	87,197
New South Wales	173	11 6	173	4.50	178	.7675	25,582	80,516
New Zealand			15	4.276	17	.8454	28,056	92,106
Russia	7	14 9	8	2.12	8	.850	25,070	82,496
Spain	7	5 6	9	2.74	9	.878	20,059	76,675
Uruguay	59	8 5	75	2.67	77	.7969	24,180	77,789
Victoria	99	9 0	101	3.52	110	.7524	25,498	84,694
United States	295	13 14	303	2.85	321	.887	25,667	80,974

If the different countries are arranged in the order of the fineness of the wool, from the finest to the coarsest, they will stand as follows:

Cape Colony	0.7405	Russia	0.850
Victoria	.7524	Argentina	.860
New South Wales	.7675	Spain	.878
Uruguay	.7969	Unted States	.887
New Zealand	.8454		

It is interesting to note that apparently a fairly close relation prevails between the gross weight of the fleece and the fineness of the staple, and that the ratio is inverse, as it were—that is, the greater the weight of the fleece the lower the fineness or the greater the diameter of the fiber. If we leave out of account the fleeces of Argentina and Uruguay, which were believed by the judges to have been skirted before being offered for exhibition, and bring together the figures for weight and fineness for the different countries offering a sufficient number of fleeces for proper comparison, we have the following:

Country.	Number of fleeces.	Weight.	Fineness.
		Lbs. ozs.	*Inch.*
United States	295	13 14	.887
New South Wales	173	11 6	.7675
Victoria	99	9 0	.7524
Cape Colony	121	7 1	.7405

In the matter of ultimate strength and modulus of elasticity, different orders will be found if we arrange the figures in descending series, thus:

Country.	Ultimate strength (per square inch of cross section).	Modulus of elasticity.
	Pounds.	
Argentina	22,096	68,619
Cape Colony	27,617	87,197
New South Wales	25,582	80,516
New Zealand	28,066	92,106
Russia	25,070	82,495
Spain	20,059	76,675
United States	25,667	80,974
Uruguay	24,180	77,789
Victoria	25,498	84,694

It is perhaps questionable upon which of the two sets of figures the manufacturing value of the staple should be based, whether upon the ultimate strength alone, or upon both the strength and elasticity combined, as illustrated in the modulus of elasticity. It will be remembered that this latter, being determined by dividing the ultimate strength or tenacity, expressed in pounds per square inch of cross section by the percentage of stretch, expressed in a decimal, suffered by the fibers of the sample at rupture—that is, this figure, or the modulus of elasticity, expresses the power required to produce a given equal amount or unit of elongation in the fiber of the assumed cross section of 1 square inch when subjected to strain. It would therefore indicate the power of the fiber to resist strain, and therefore its power to resist wear. For this reason, in our previous work (Report of 1886) we used this modulus of elasticity as the standard of value and it would still seem to be the natural one.

The grade Merino wools of Argentina are almost worthy to be classed among the pure-bred wools, for they are of such high quality. While the weight of the fleece is small, the wool is of good length, 2.65 inches, and its fineness is even superior to that of the pure-bred Merino wool, being 0.837 inch against 0.860. And in the matter of strength and elasticity there is practically no difference. The figures illustrate the value of the great Mestizo flocks of Argentina, and show how carefully the selection of stock in breeding has been carried on, and how thoroughly the qualities of the fine wooled Merino blood has been fixed.

An attempt to compare in the same way the fine wools of the different States of our country seems almost useless. In the first place, so many of the States are not represented at all, while others are so inadequately represented as to make the results of no practical value. Such as they are, however, we will offer them.

State.	Number of samples.	Weight of fleeces.	Number of samples.	Length of staple.	Number of samples.	Fineness.	Ultimate strength (per square inch of cross section).	Modulus of elasticity.
		Lbs. ozs.		*Inches.*		*Inch.*	*Pounds.*	
Arizona	1	10 1	1	1.30	1	.785	22,062	79,208
Colorado	2	18 4	1	2.50	2	.922	26,972	87,517
Illinois	1	16 9	1	2.00	1	1.049	21,838	83,994
Iowa	11	11 9	11	2.70	12	.813	20,079	57,428
Michigan	10	20 2	6	2.35	11	.844	27,887	89,566
Missouri	20	19 10	18	2.11	20	.886	23,606	72,288
Montana*	13	10 5	13	2.79	13	.804	26,344	86,845
New York	20	15 15	15	2.40	20	.816	24,530	78,738
Ohio	168	11 2	164	3.11	165	.903	24,871	78,960
Pennsylvania	21	13 0	20	3.12	21	.836	22,200	63,889
South Dakota	3	10 9	2	2.53	3	.777	38,795	122,715
Utah		3 0	2	3.07	2	.773	20,991	78,775
Vermont	15	22 7	15	2.67	15	1.028	31,158	100,462
West Virgina	7	7 3	6	2.08	7	.778	25,914	81,913
Wisconsin	36	16 5	37	2.53	37	.908	24,980	95,742
Wyoming	4	14 6	3	3.08	4	.852	27,470	90,955

*Grade Merino.

Now, if we arrange in the order of the general averages of fineness for the fine-wool fleeces, and particularly the fine-bred Merino, those States which offered any considerably number, we have the following exhibit:

State.	Number of fleeces.	Fineness.
West Virginia	7	.778
Montana	13	.804
Iowa	11	.813
New York	20	.816
Pennsylvania	21	.836
Michigan	10	.844
Missouri	20	.886
Ohio	168	.903
Wisconsin	36	.908
Vermont	15	1.028

Both West Virginia and Pennsylvania exhibited larger numbers of fleeces, but as information concerning them was lacking, samples were not taken from them. A larger collection would doubtless cause important changes in the order here presented.

Again arranging the States in the order of the qualities of strength and elasticity, we have some further interesting relations:

State.	Strength.	Modulus of elasticity.
Vermont	31,158	100,462
Michigan	27,887	95,742
Montana	26,344	89,566
West Virginia	25,914	86,845
Wisconsin	24,980	81,913
Ohio	24,871	78,960
New York	24,530	78,738
Missouri	23,606	72,288
Pennsylvania	22,200	63,889
Iowa	20,079	57,428

It is almost, if not quite, unprecedented to find so close a relation between the strength and elasticity as is here shown. The only exception in the entire list is Wisconsin. If this were left out, the States would occupy exactly the same order as regards both the qualities represented. Most of the animals represented in the fleeces giving these figures were, it may almost fairly be presumed, from stud flocks, and it would be interesting to extend the investigation and determine whether in all cases when animals are carefully selected and cared for this close relation between strength and elasticity prevails.

It will be interesting to compare with the figures given above the results of a special examination of merino wools from the different States collected in 1882. These are as follows:

General averages of all results of tests made in 1880 to 1883 upon merino wools from different States.

States.	Number of samples.	Centimillimeters.	Thousandths of inch.	Fractions of inch.	Ultimate strength per square inch cross section.	Modulus of elasticity.
					Pounds.	
California	42	1.892	0.7443	1/1343	21,981	61,946
Illinois	40	1.925	.7578	1/1319	22,774	91,751
Minnesota	40	2.042	.8039	1/1243	26,879	77,010
New York	29	2.033	.8003	1/1249	21,382	63,795
Pennsylvania	34	1.734	.6826	1/1465	28,259	68,000
Texas	21	1.890	.7440	1/1343	19,918	52,197
Vermont	44	2.000	.7874	1/1269	19,280	68,360
Wisconsin	80	2.169	.8359	1/1196	22,031	62,667

Unfortunately, again, only four of the States practically occur in both tables: New York, Pennsylvania, Vermont, and Wisconsin. We may, however, bring these together for more ready comparison.

States.	Fineness.		Ultimate strength.		Modulus of elasticity.	
	1882.	1893.	1882.	1893.	1882.	1893.
New York	.8003	.816	21,382	24,530	63,795	78,735
Pennsylvania	.6826	.836	23,259	22,200	63,000	63,889
Vermont	.7874	1.028	19,280	31,158	68,360	100,462
Wisconsin	.8359	.908	22,031	24,980	62,667	95,742

So it seems that there has been pretty general increase in the average diameter of the fiber in these States, and, with the exception of Pennsylvania, in the ultimate strength and elasticity as well. It further illustrates the fact that our breeders by seeking larger frame and hardier constitutions have sacrificed fineness to the other qualities which have been improved.

Before leaving this subject we should call attention to the comparatively high strength and elasticity of the wools from the States located in the high elevations west of the Mississippi. Although the few fleeces from there were unprepossessing in appearance for the most

part and indicated deficient care of the flocks, the wool was of good quality and shows the possibilities of the section for yielding a good product. The modulus of elasticity is in some cases exceptionally high; thus:

States.	Number of samples.	Fineness.	Strength.	Modulus of elasticity.
Arizona	1	.785	22,062	79,208
Colorado	2	.922	26,972	87,517
Montana	13	.804	26,344	86,845
South Dakota	3	.777	38,796	122,715
Utah	2	.773	20,991	78,775
Wyoming	4	.852	27,470	90,955

In two cases, Arizona and Utah, the strength is almost abnormally low, and it is possible that all these figures might be greatly modified if a larger number of samples were examined, but they are significant and should lead to further study of the wools of that section.

Now we may take up the consideration of the different breeds as they are related to each other in the qualities of their wools. It is true that as they are bred and grown for such widely different purposes, the Merinos principally for their fine wools and the middle and long wool breeds principally for their mutton, we should expect to find the highest qualities in the merino wools. Our expectations, however, are not always realized, and this is particularly the case in the present instance.

To compare these breeds in the relations of fineness, length, and weight of fleece is also almost useless. In the matter of fineness the Merino stands alone; in its uses, too, for the coarse wools can by no means enter into the fine and delicate fibers to the manufacture of which the merino wool is devoted. Between themselves, however, they may be compared upon all these points, and, in view of the work being done in the different countries, with a good deal of profit. Unfortunately, however, we are unable to extend our study to any extent to the wools of foreign countries, because we have not had the material. Naturally, in entering into an exhibition of wool the greatest competition is expected to be in the fine wools, and for this reason, perhaps, only such were sent to the Exposition. Practically, only the Argentine Republic, Uruguay, and New South Wales are represented in the coarse wools. In each case the Lincoln seems to lead all the other breeds in strength and elasticity, and, if we leave out of account the Merino, in fineness also. We shall bring more closely together for the purposes of comparison these breeds from the different countries, confining ourselves, however, to simply the strength and elasticity.

	Lincoln.		Leicester.		Shropshire.		Merino.	
	Strength.	Modulus of elasticity.	Strength.	Modulus of elasticity.	Strength.	Modulus of elasticity.	Strength.	Modulus of elasticity.
Argentine Republic	[a] 37,061	119,172					[b] 22,096	68,619
New South Wales	[c] 43,115	97,554	[d] 30,708	90,693			[e] 25,582	80,516
Uruguay	[f] 35,335	91,334			[g] 27,281	79,848	[h] 24,180	77,789

[a] 22 samples. [b] 33 samples. [c] 5 samples. [d] 6 samples. [e] 173 samples. [f] 9 samples. [g] 2 samples. [h] 59 samples.

In this table the merino fleeces represented are so much more numerous and the numbers of the fleeces from other breeds so limited that it is possible that here, too, an equalization of the number of samples examined might bring about a change in the relations considered. The figures obtained from samples from the Argentine Republic, as well as the others, lead undoubtedly to the conclusion that the Lincoln wool is superior to that from the other breeds and particularly better than the Merino. And this superiority of quality holds even in the crosses, for we find with greater intensity of the Lincoln blood in the cross higher figures for strength and elasticity, and that as the Lincoln blood declines with repeated crossing and intensification of the Merino blood these qualities decline.

In the wools from the United States we have better opportunities for comparison and the relations are most interesting. Here the greater interest in the coarse-wool breeds attaches to the Downs, and the indications are that flocks of these breeds are the more numerous and that the long-wool breeds, such as the Leicester, Cotswold, and Lincoln, are giving way to them. Nevertheless we shall find that the latter at the present time, so far as we can judge from our figures, are producing stronger and more elastic wools. Let us bring together and arrange in the order of their fineness the pure-bred wools of the United States represented in the Exposition.

Breed.	1893.		1880.	
	Number of samples.	Fineness.	Number of samples.	Fineness.
Merino	321	0.887	390	0.798
Hampshire Down	14	1.137		
Southdown	41	1.166	20	1.119
Dorset Horn	6	1.192		
Shropshire Down	77	1.321		
Cheviot	5	1.339		
Oxford Down	35	1.384	4	1.737
Lincoln	6	1.407	9	1.48
Cotswold	37	1.413	27	1.65

Generally, then, the Down wools are finer than the long wools. They are very different in the qualities of softness and sometimes of luster, though in the latter particular they rank fairly high. The relations of fineness between the breeds seem to have changed somewhat since 1880.

if the collections we were able to make at that time may be considered representative. Certainly the material was then obtained from highly bred animals produced under conditions favorable to the growth of good wool. In the last column we have entered the results of the measurements of fineness made in our earlier work. Here we find that the Oxford Down breed furnished the coarsest wool. With this exception, however, the breeds stand in the same order in both cases. Still, in the earlier investigation only 4 samples of Oxford Down wool were tested and in the latter 35. Here again is the possibility of having a more accurate average had a larger number of samples been examined.

In this comparison we have left out of account the result for the single sample of native wool from the West. It may have been exceptional, and yet the average fineness is good and the strength and elasticity both very high. The native sheep have had such a powerful influence in the formation of the large flocks of the West that further study of their qualities would be full of interest and, doubtless, of value also. If the qualities here shown should prove to be prevalent and the figures to represent true averages, would it not be worth while to carefully breed these sheep to be used for communication of the high qualities to the wool-prodncing breeds? They have been so extensively used, particularly in the Southwest, as a basis for the formation of the ranch flocks, that they have become an important factor in the sheep and wool history of this country.

The following table exhibits the order in which the several breeds of the United States stand to each other in the matter of strength and elasticity:

Breed.	Number of samples.	Strength.	Breed.	Number of samples.	Modulus of elasticity.
Cheviot	5	32,884	Cotswold	37	84,271
Cotswold	37	31,598	Merino	295	80,974
Lincoln	6	31,499	Shropshire Down	77	79,745
Oxford Down	35	28,751	Southdown	41	79,604
Dorset Horn	6	27,120	Cheviot	5	77,725
Shropshire Down	77	27,037	Lincoln	6	76,719
Merino	295	25,667	Hampshire Down	14	75,021
Southdown	41	24,551	Oxford Down	35	74,761
Hampshire Down	14	24,241	Dorset Horn	6	61,408
Fat Tail (Turkey)	11	10,191	Fat Tail (Turkey)	11	59,108

These general averages show that as regards the ultimate strength or tenacity the merino stands pretty well down in the scale and that the long wools lead. It is really interesting to note how remarkably close this quality is allied to the fineness. In our fineness table, immediately preceding, reading from the bottom upward, we have the Cotswold, Lincoln, and Oxford Down in the order named, and we have them in the same order reading downward in the table before us. Here the Cheviot leads; in the former table it would foot the list. At

any rate the four breeds occupy opposite ends of the column in the two tables, and the figures thus support the relation, and the coarser fibers are relatively stronger.

In the combination of the qualities of strength and elasticity expressed in the modulus of elasticity, which we have agreed shall serve us as the standard of the value of the wools for manufacturing purposes, we have still a different order. Here the Merino stands at the other end of the scale and is second only to the Cotswold. The Shropshire Down and Southdown are higher in the scale, and the Cheviot, which in the column for strength stands at the top, forms the median line as it were, being nearly an average of the two extremes.

Let us now consider the like figures obtained for the same breeds in 1880 to 1883. They are as follows:

Breed.	Number of samples.	Strength.	Breed.	Number of samples.	Modulus of elasticity.
Southdown	20	33,388	Southdown	20	150,990
Lincoln	9	30,116	Lincoln	9	88,085
Cotswold	27	29,493	Cotswold	27	83,643
Oxford	4	27,963	Merino	390	74,308
Merino	390	22,656	Oxford Down	4	72,034

How different are the relations here! The Southdown leads both in the strength and modulus of elasticity in the earlier tests, while in the present investigation it takes only a medium or even inferior position. Before, the Merino wools occupied an inferior position as regards both the ultimate strength and the modulus of elasticity, or general value for manufacturing. Our later works place it next to the head of the list for the latter most important quality. We have already stated that the Southdown breed, once so popular in this country, is declining in favor. Has a diminution of enthusiasm with regard to it led to less care in breeding it, and so brought about a deterioration in the quality of the wool? Does it not seem an apt illustration of the necessity for the highest and best care and selection in the maintenance of flocks and the quality of their products?

Our later results would not seem to justify the decline in favor manifested toward the long-wool breeds, if we may judge from our results and confine ourselves to these considerations alone. The Cotswold breed has an excellent record and is worthy of thoughtful attention and study. Evidently progress has been made during the past ten years in breeding it. Its relation to the other breeds in the quality of the wool, as exhibited in these results, has decidedly changed, and in the study of the internal structure of the fiber we have likewise noticed differences which must have an important influence upon its strength. Thus, in our earlier study of the fiber the pigment canal through the middle of it was very prominent and extensively developed. In our later examinations this was much less marked, the fibers

were far more uniform in structure throughout, and the fibro-cellular structure more homogeneous. The breed has been led further away from the native type of aboriginal sheep, in which the peculiarity mentioned is quite prominent.

The modulus of elasticity for the Shropshire Down justifies the favor accorded it by the breeders in all parts of the United States. It yields a fleece of good weight, and wool which is not too coarse for certain kinds of clothing, and particularly of blankets, while its manufacturing and wearing value is high. It would seem to be the coming mutton breed, combining, as it does in a large degree, the abundant production of good mutton and good wool.

The Cheviot and the Dorset Horn are the latest additions to the breeds of the country, and the value of their products remain to be fully determined. The few fleeces of Cheviot wool examined have given good results, such as must encourage those who have taken them up, The superior strength and the reasonably high modulus of elasticity commend them to our favorable consideration. In the hands of American breeders they will doubtless grow in prominence and value and find a useful place in our sheep-breeding economy.

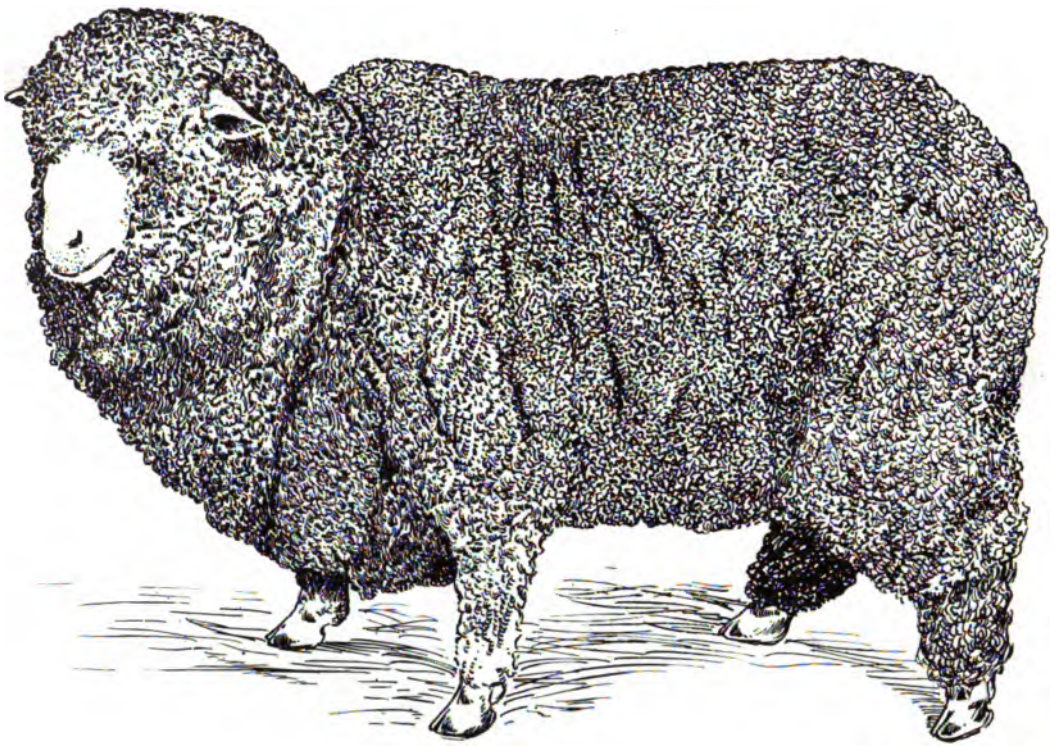
The study of the minute structure of the fiber has led us to consider that the Dorset Horn would be a valuable addition to our list of breeds, particularly for intermingling with the Merino blood. In its fineness and length it is more closely allied with the coarser wool Down breeds. But in the minute structure of the fiber it is more closely allied than they to the Merino breeds. The wool is softer and smoother, similar indeed, in this respect, to the Lincoln; but in the arrangement and structure of the epithelial sheath it favors more closely the Merino. Perhaps further breeding in this country will develop higher qualities than are shown here, or examination of a larger number of samples from other and different localities will furnish different and better results. At any rate it is our present feeling that no discouragement should be produced by the figures here presented and that the breed is worthy of the most careful and persistent attention.

It is interesting to note that the Lincoln breed is the favorite among the larger bodied breeds in foreign countries and that the wool produced by it is of the highest quality and considerably better than that produced by the same breed in the United States. Compare for instance the strength and modulus of elasticity of the Lincoln wools of the Argentine Republic, Uruguay, New South Wales, and the United States, thus:

Country.	Number of samples.	Strength.	Modulus of elasticity.
Argentine Republic	22	37,081	119,172
Uruguay	11	35,335	91,334
New South Wales	5	43,115	97,554
United States	6	31,499	76,719

In the foreign countries named the Lincoln constitutes extensive stud flocks and it is carefully bred for the purpose of crossing with the Merino to secure a larger carcass for the frozen-meat trade, combined with fine, soft, medium wool for market. Has the apparent neglect of the breed in this country caused deterioration of its wool?

Our tables show that in all countries the practice of crossing the breeds is very common and in many cases this has brought valuable results. It is particularly the case in our own country, where, as has already been stated, so much has been accomplished by crossing the native Mexican with the best Merino blood, and in the Argentine Republic, which furnishes interesting in the Mestizo and grade Merinos. In many cases the quality of the wool yielded is as high as that furnished by the Merino, not only in fineness, but in strength and elasticity as well. But generally, as might be expected, it is slightly inferior, and lacks the strength and spring common to the pure-bred wool. In this country the struggle to secure larger wool-bearing animals has led to intermingling of blood, and in later years the Downs and the Merino seem to make the more popular crossing. Our tables show a good many such. Without entering into details we may call attention to the exhibits from South Dakota in which the definite crosses are so largely represented, but particularly to those from Wisconsin. From the latter State some cross-bred wools were sent from the State University and individuals, including representatives of crosses of Shropshire and Oxford Downs with the Merino. In the case of the Shropshire crosses we find that in all qualities the wool of the first cross is superior, while in the Oxford crosses the results are variable, the weight of fleece declines, the length of staple increases, the wool becomes coarser but stronger and better with increase of the Oxford blood. Such results should be multiplied under intelligent direction. They are full of suggestion, and experiment in this line must prove exceedingly fruitful.



TYPICAL MODERN MERINO SHEEP.

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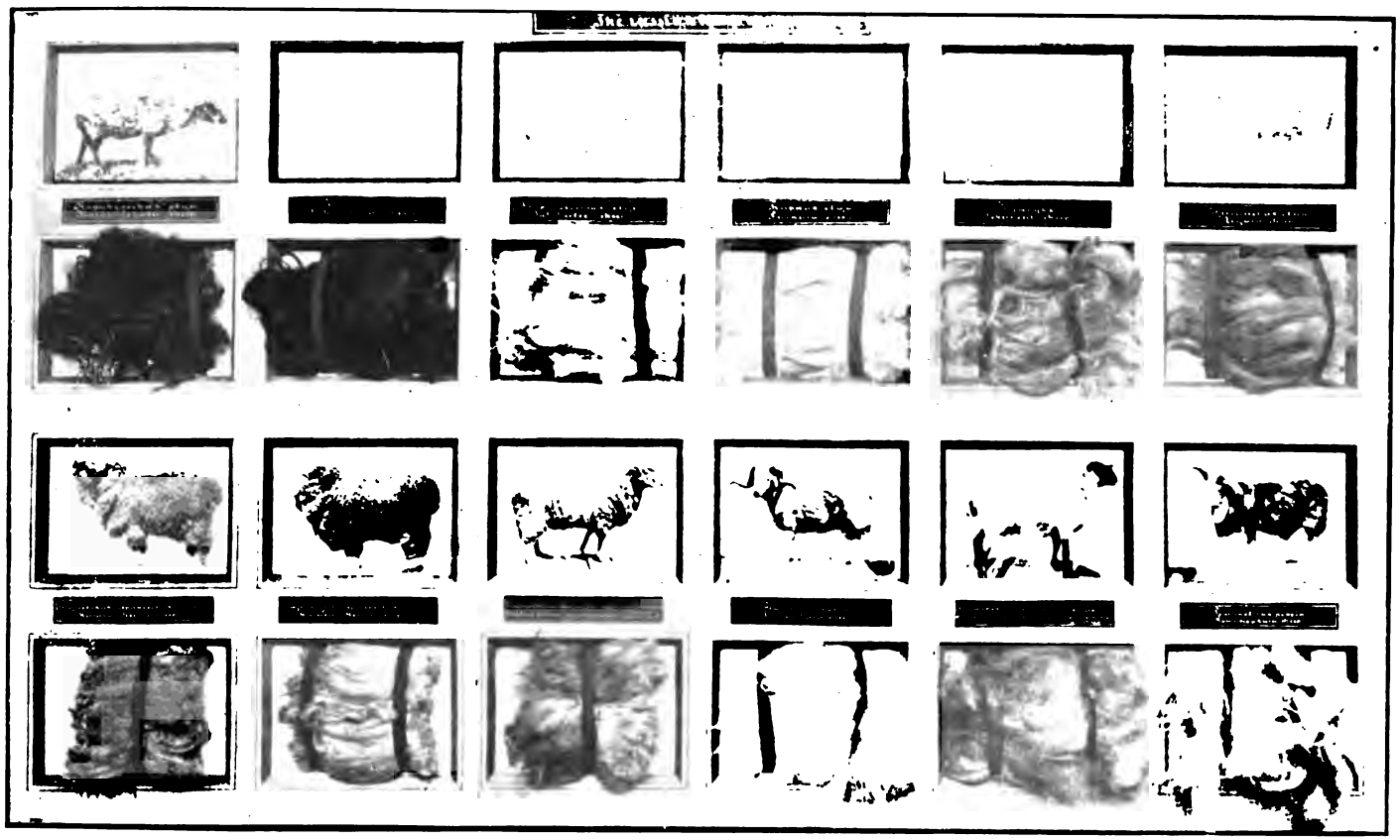

RUSSIAN BREEDS OF SHEEP.

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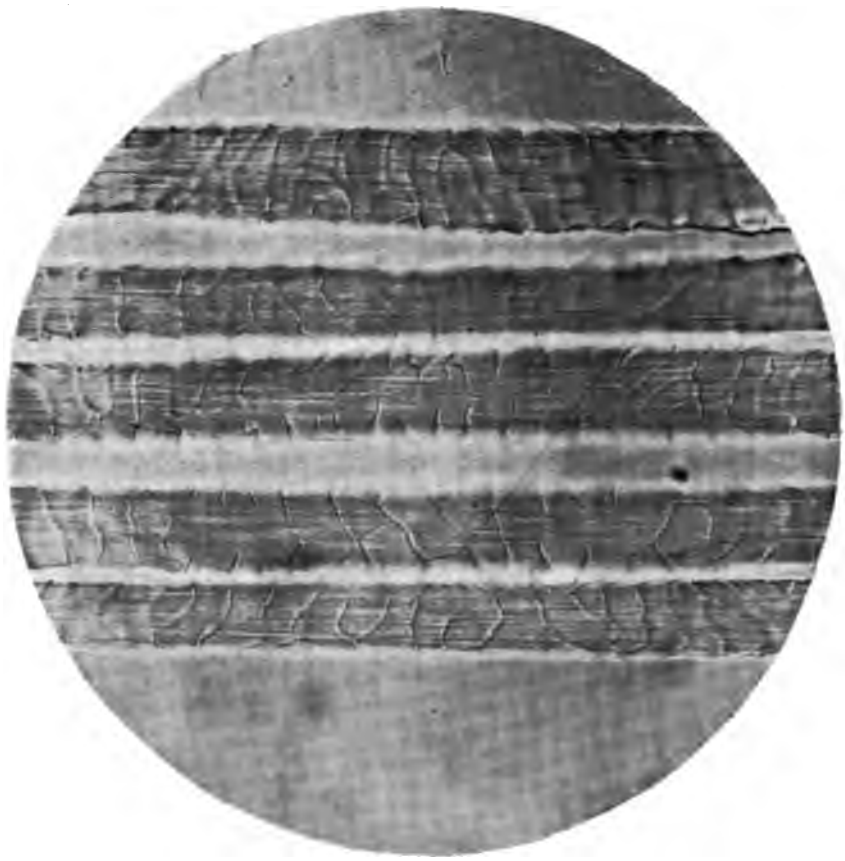

MERINO, CAPE COLONY, 112.

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MERINO. VICTORIA 21687.

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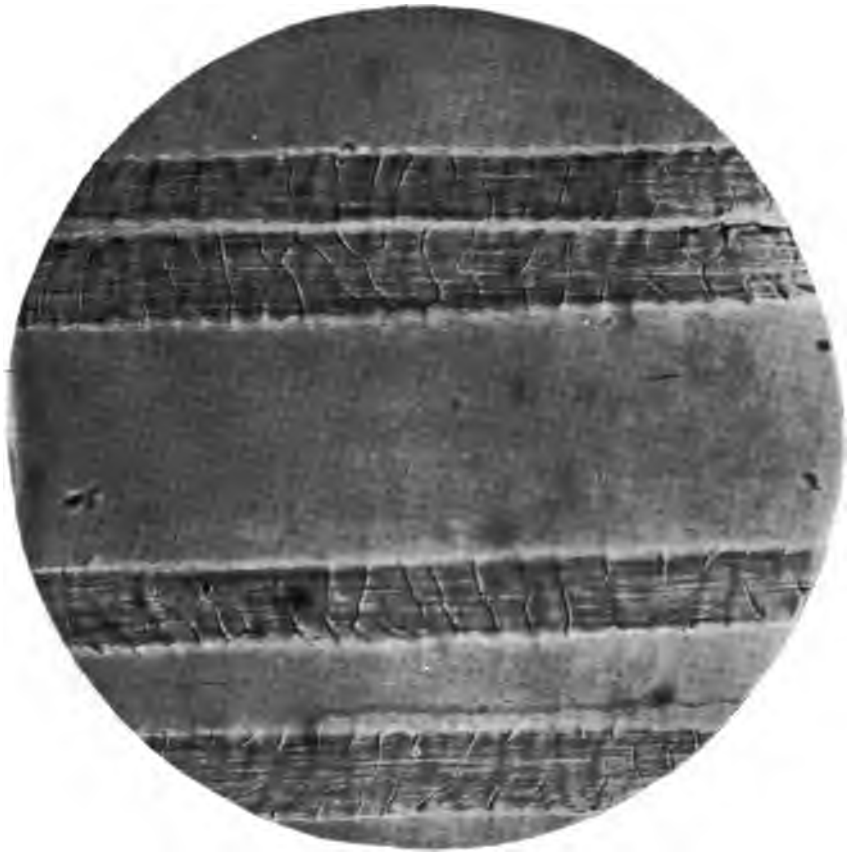

MERINO, NEW SOUTH WALES, 127.

MERINO, NEW ZEALAND, D. McL. NO. 2.

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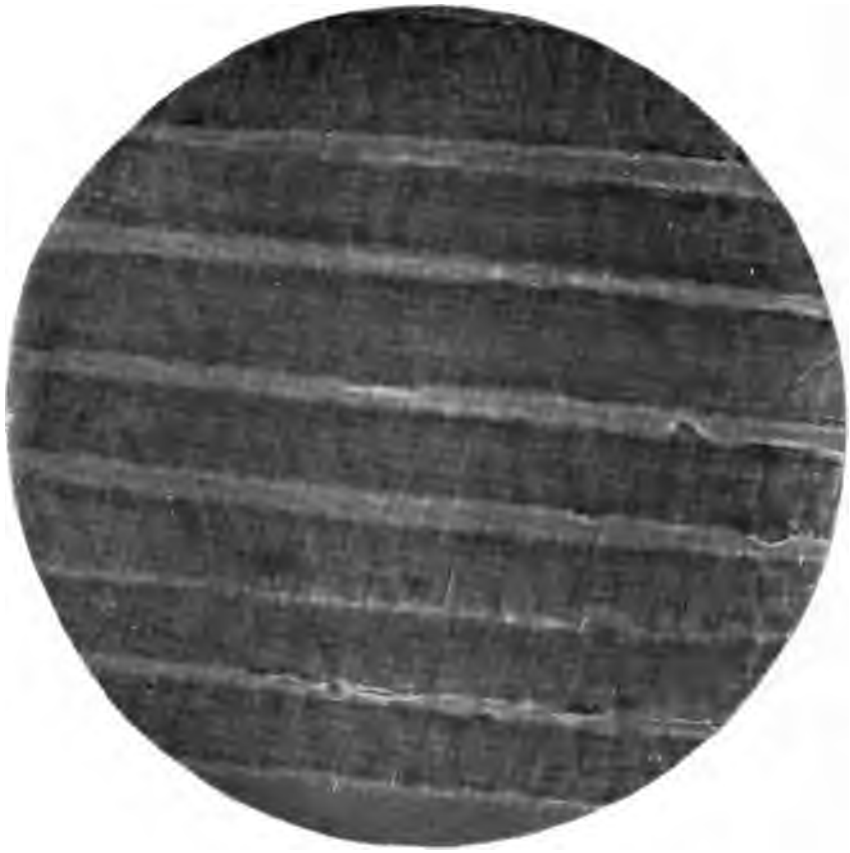
Main



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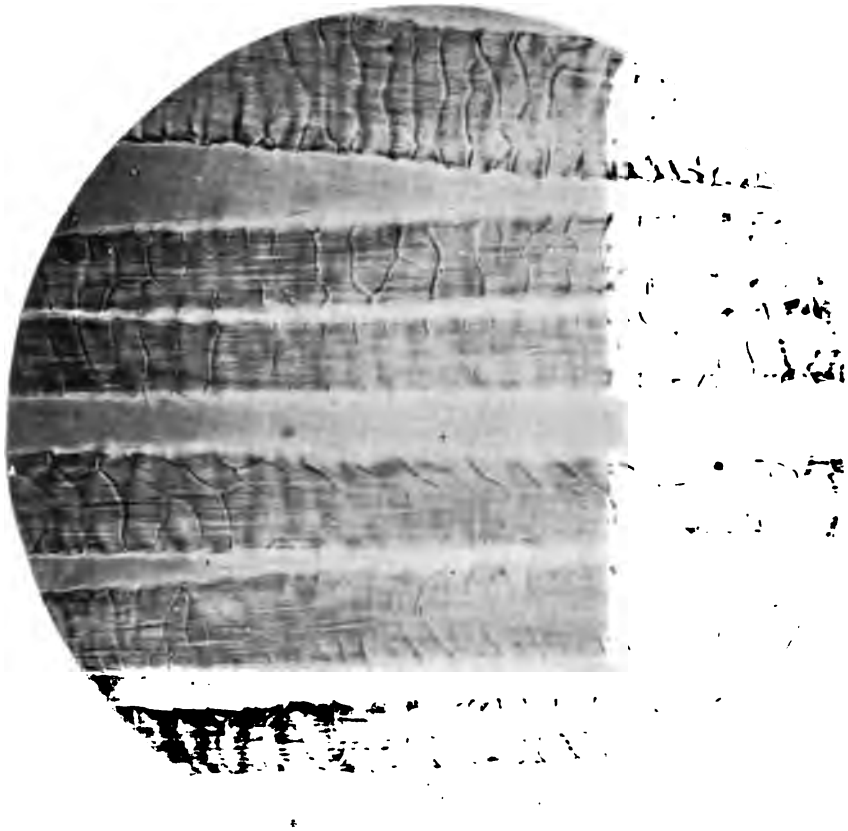

INFANTADO, RUSSIA, 24.

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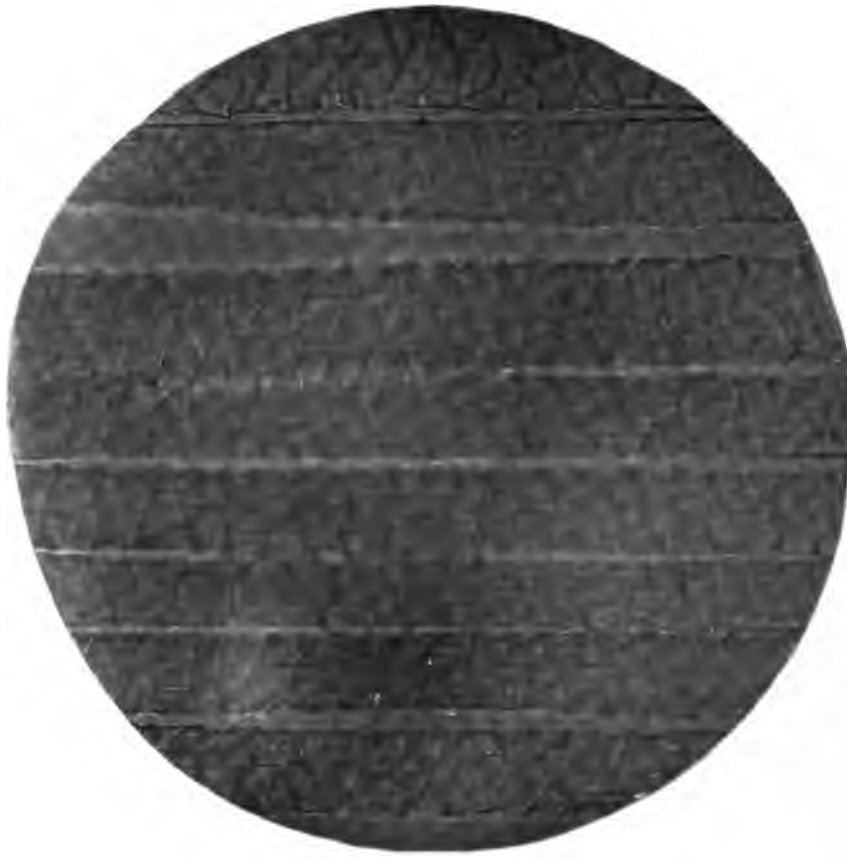
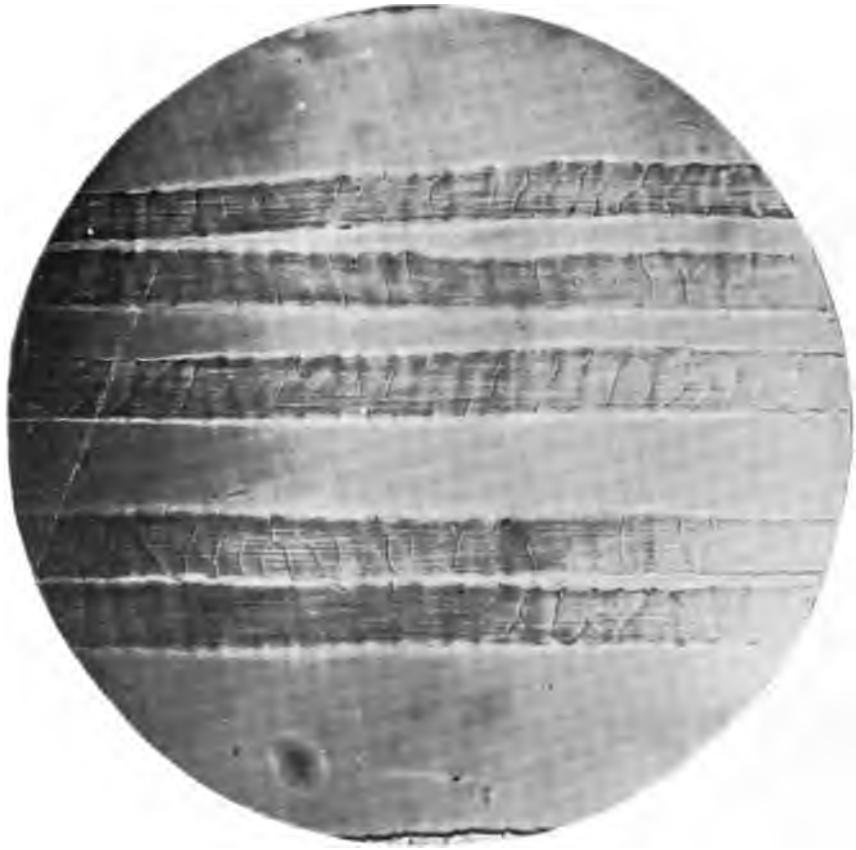
MERINO, SPAIN, E.

NOTICE



MERINO, NEW YORK, 8.



SAXON, WEST VIRGINIA, 4.

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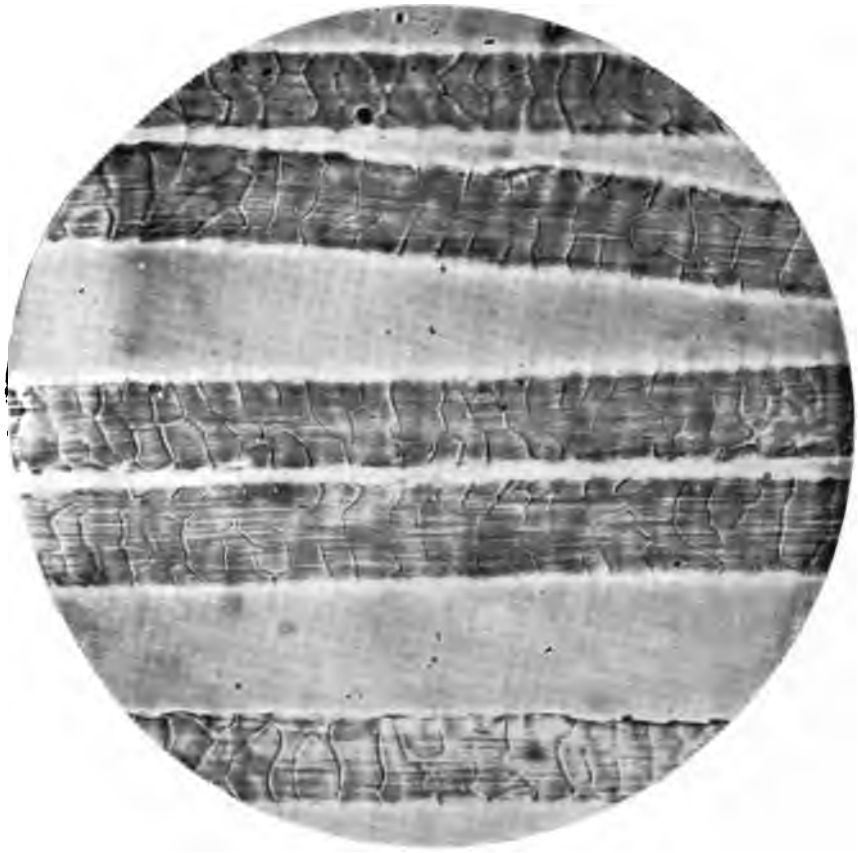

MERINO, OHIO, 5078.

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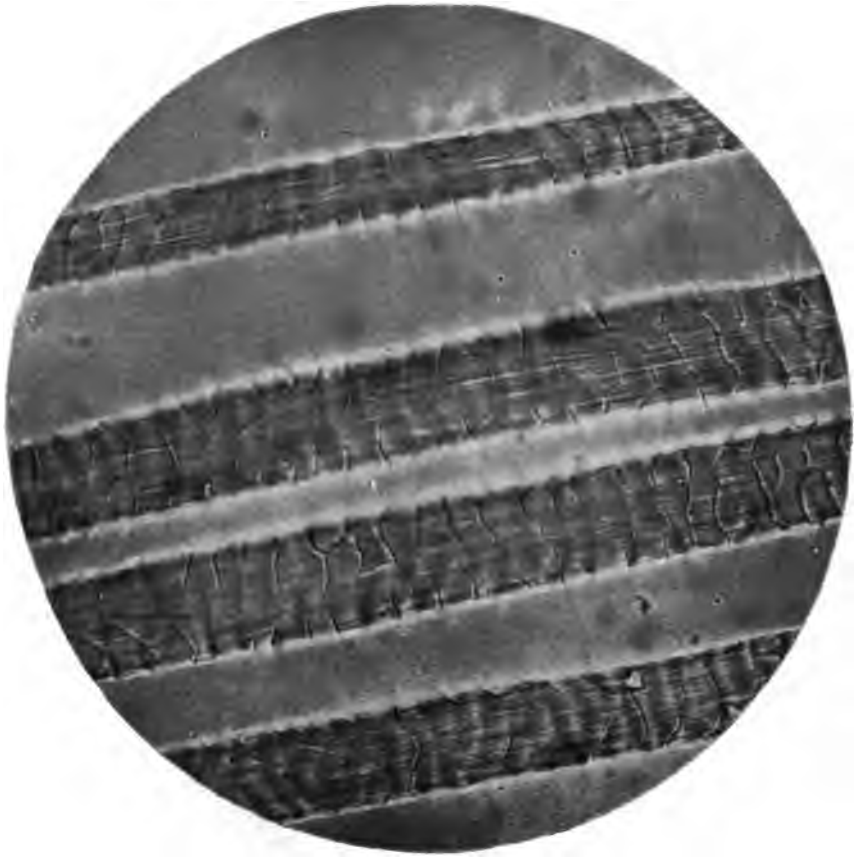

MERINO, MISSOURI, 5390.

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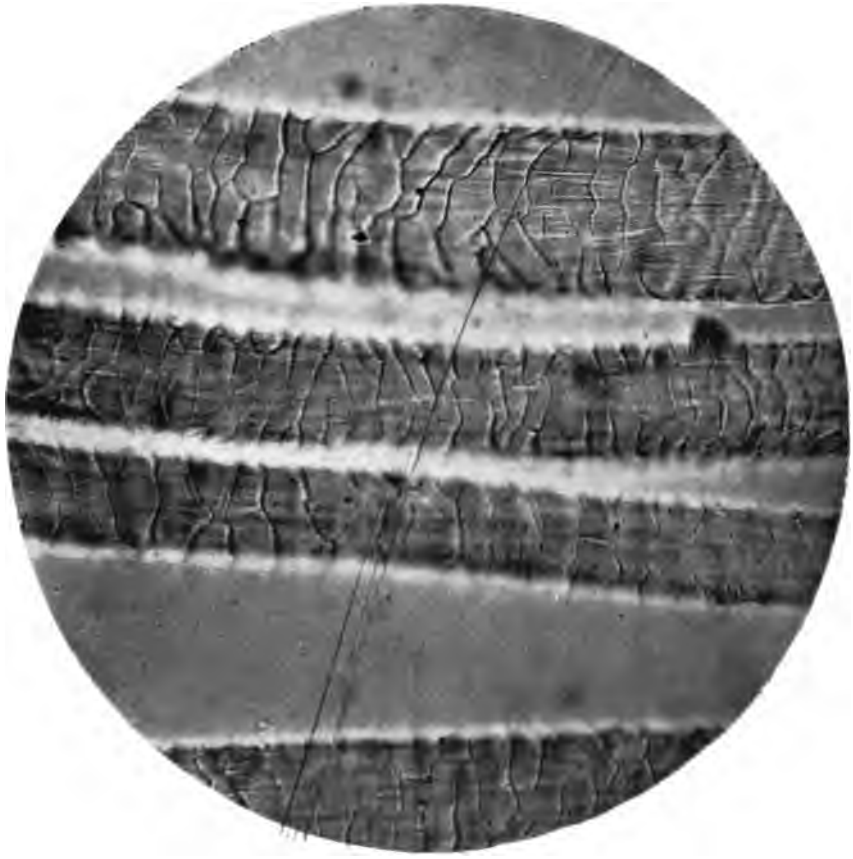

MERINO, VERMONT, 12.

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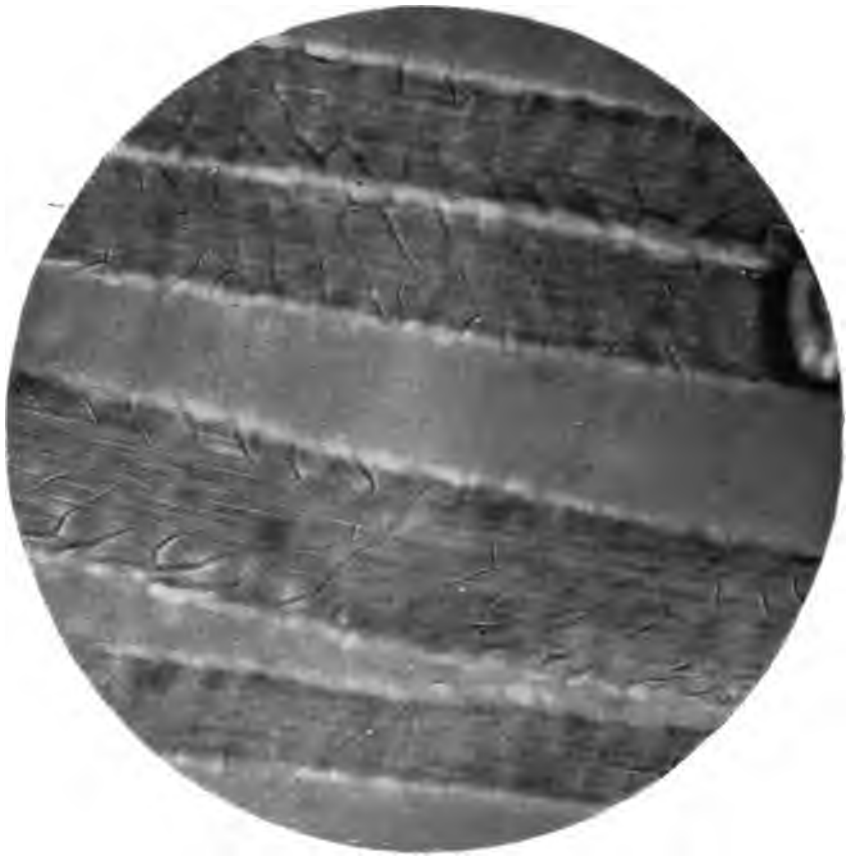
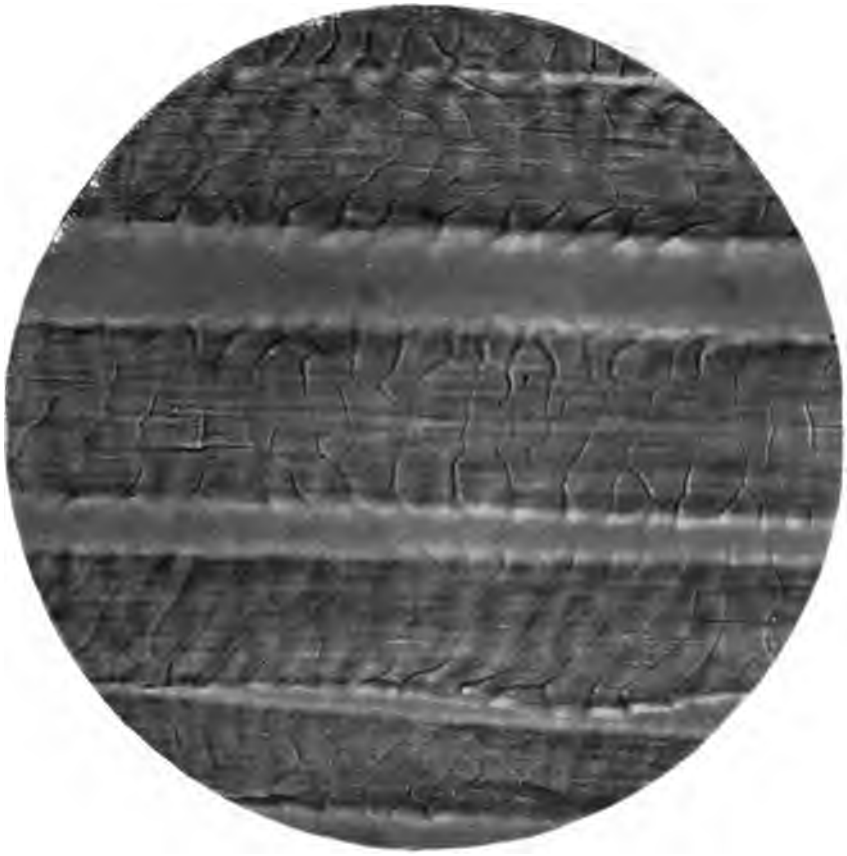
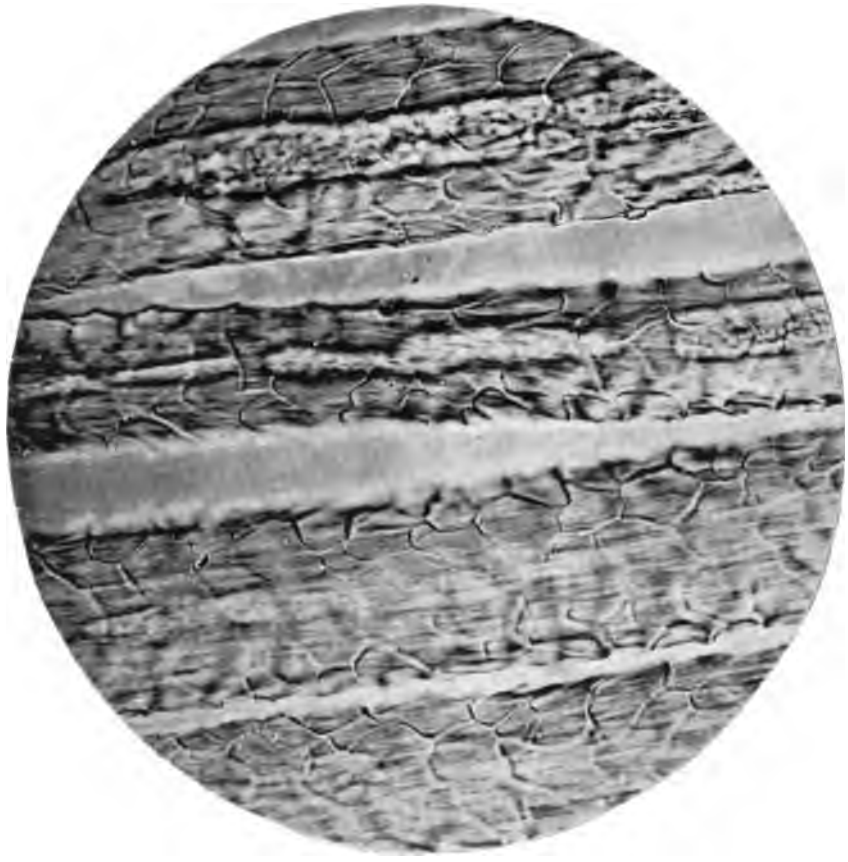


SOUTHDOWN, NEW YORK, 4668.



HAMPSHIRE DOWN, WISCONSIN, 85.



OXFORDSHIRE DOWN, NEW YORK, 4671.

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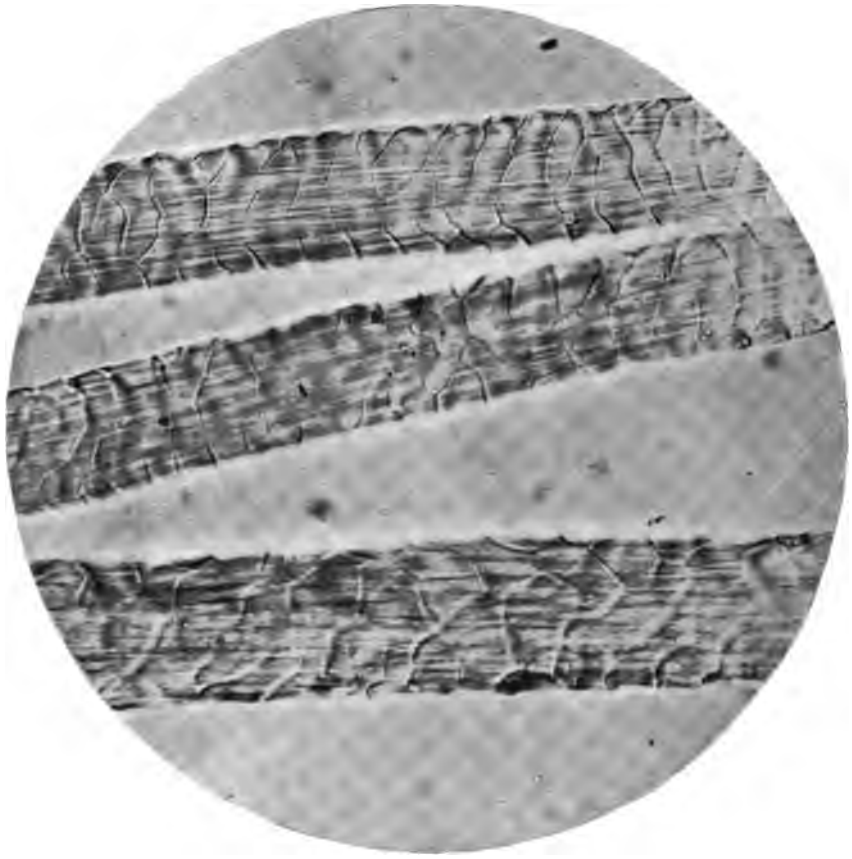

SHROPSHIRE, NEW YORK, 22.

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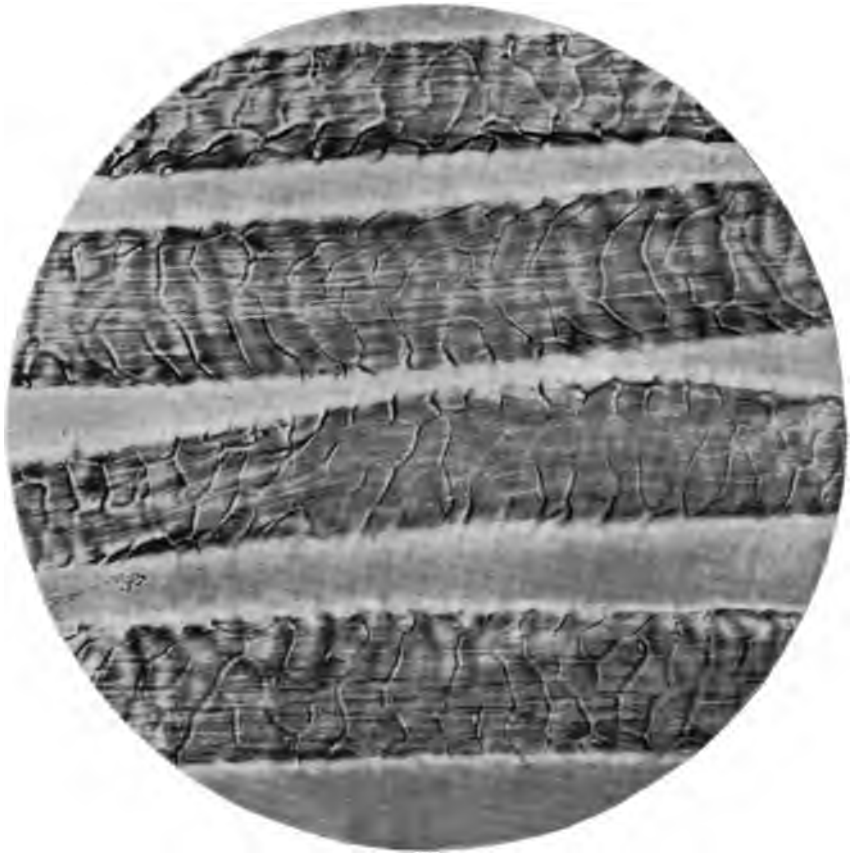

DORSET HORN, SOUTH DAKOTA, 24244.

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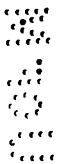

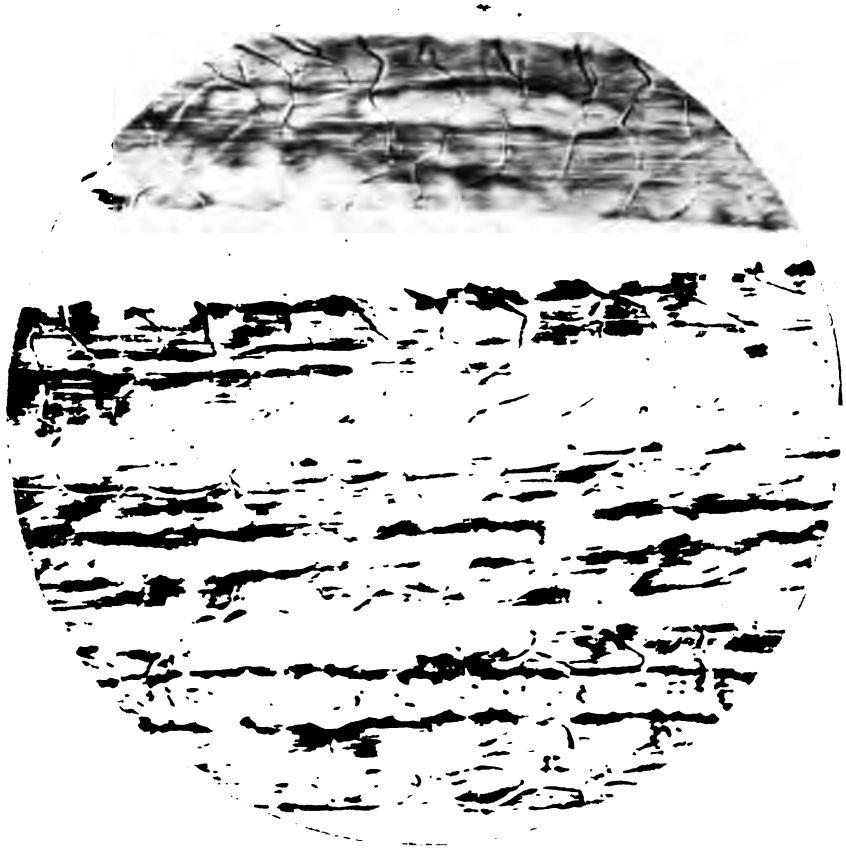

CHEVIOT, NEW YORK, 4649.

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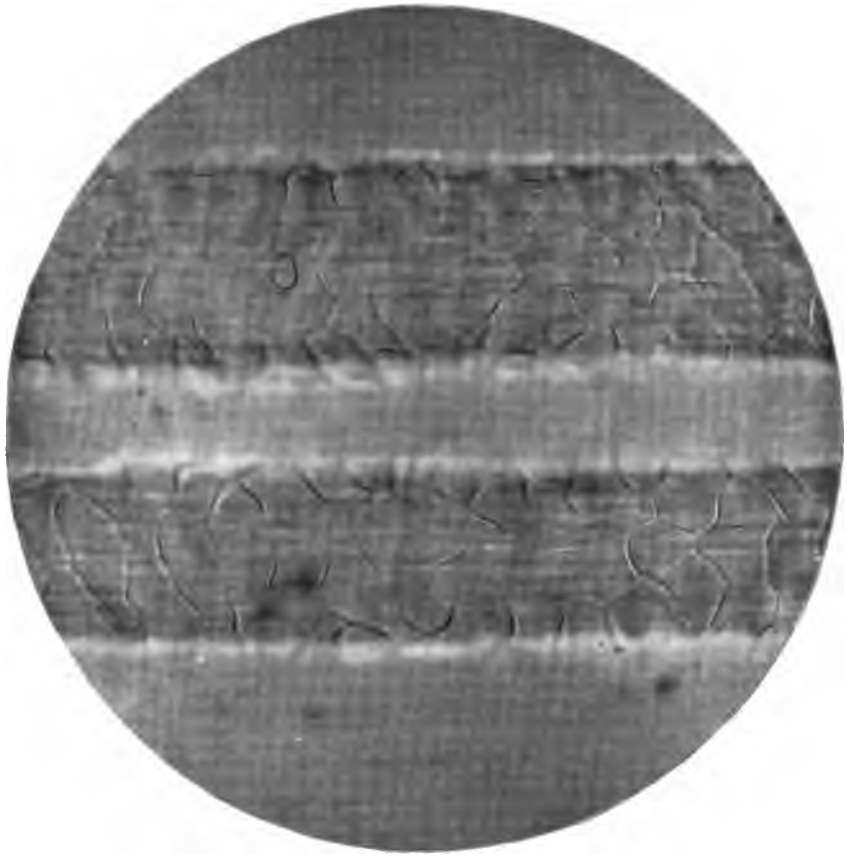

COTSWOLD, NEW YORK, 4643.

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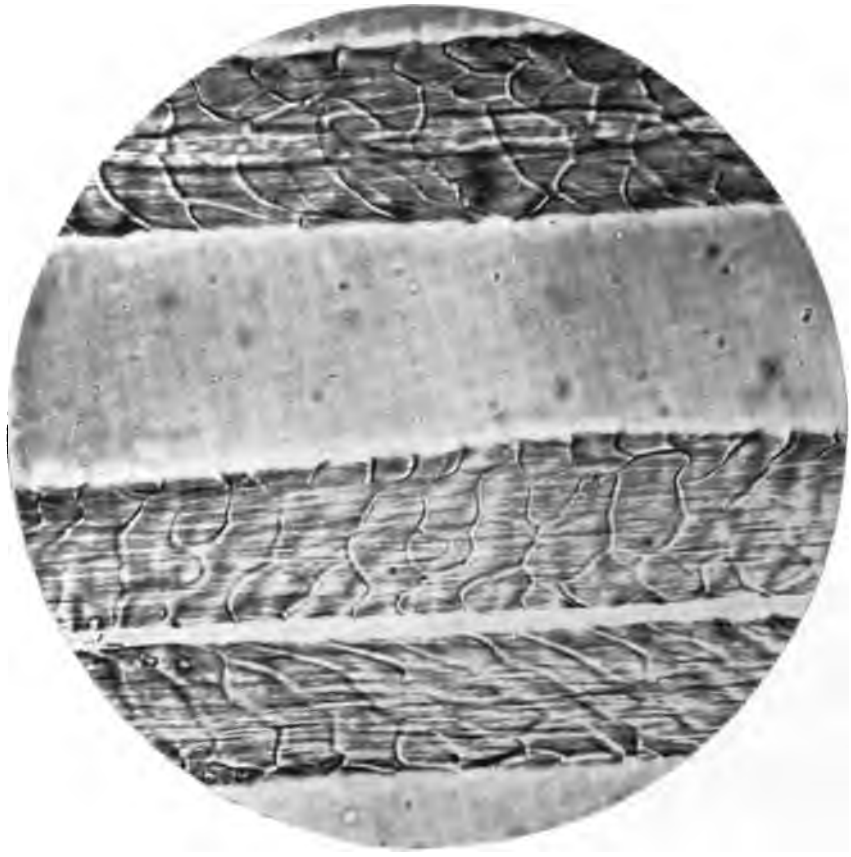

LEICESTER, NEW SOUTH WALES, 249.

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LINCOLN, WISCONSIN, 29.

ONE-HALF MERINO AND ONE-HALF SHROPSHIRE, SOUTH DAKOTA, 24260.

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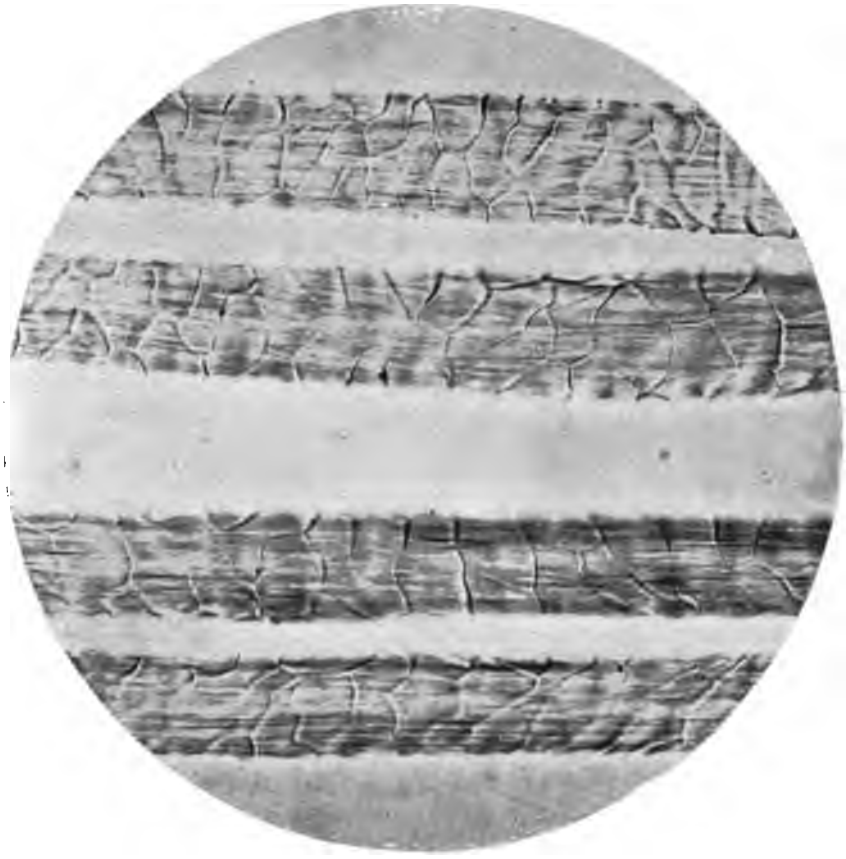
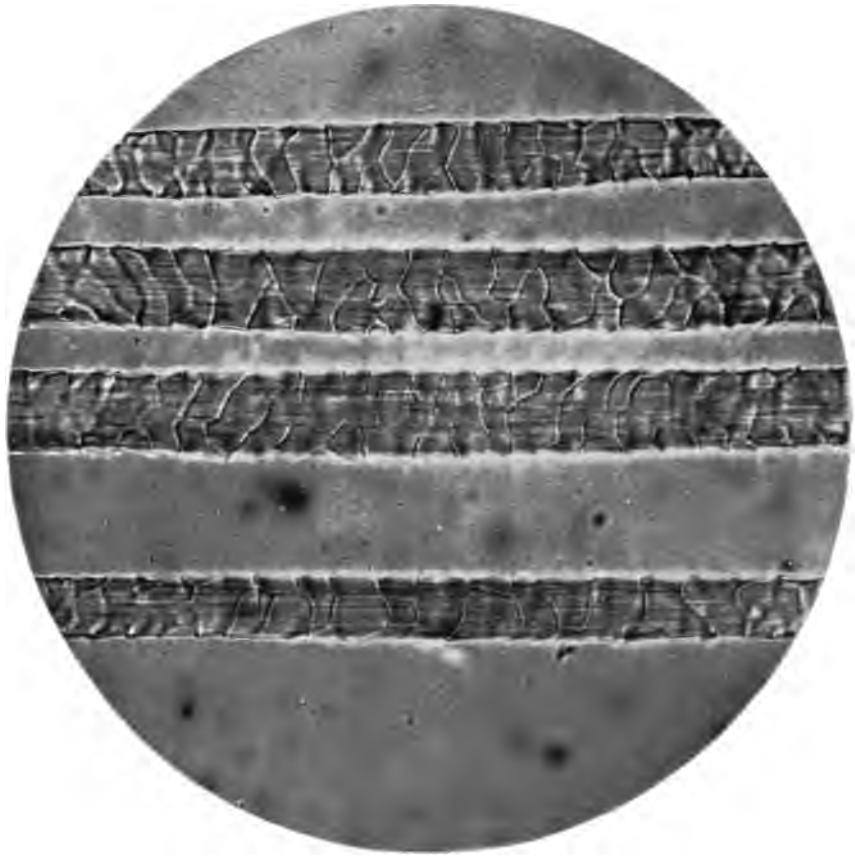


ONE-FOURTH MERINO AND THREE-FOURTHS SHROPSHIRE, SOUTH DAKOTA, 24243.

ONE-EIGHTH MERINO AND SEVEN-EIGHTHS SHROPSHIRE, SOUTH DAKOTA, 24262.



MERINO AND SOUTHDOWN ANGORA, 27055.

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MERINO AND OXFORDSHIRE, MONTANA, 15.

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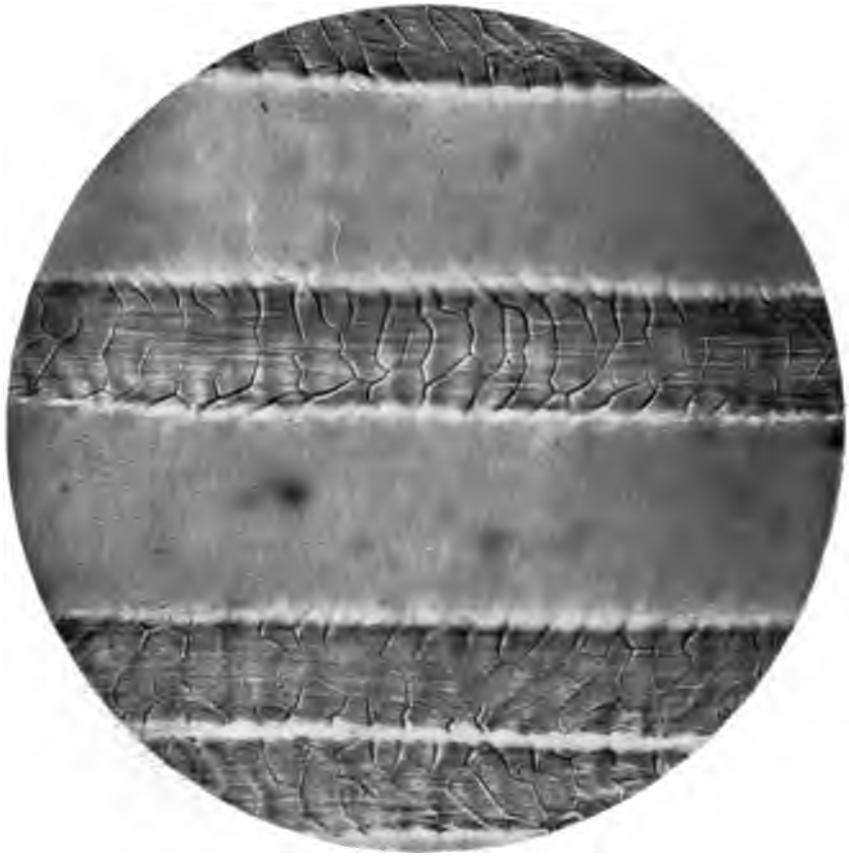
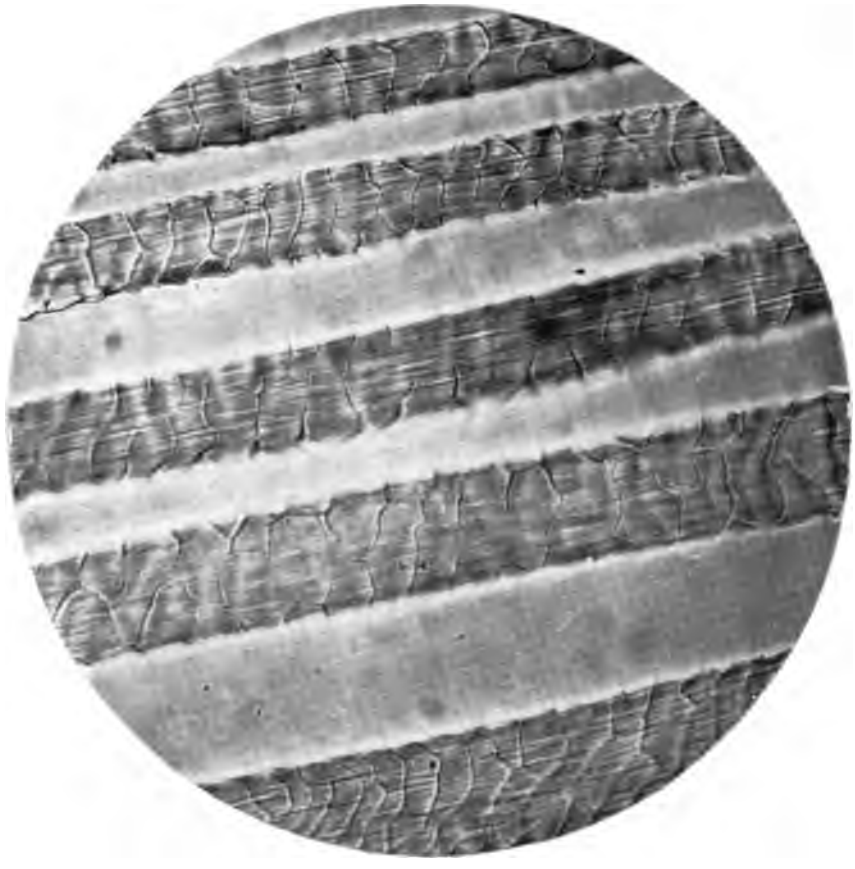


ONE-HALF MERINO AND ONE-HALF COTSWOLD, SOUTH DAKOTA, 24270.



THREE-FOURTHS MERINO AND ONE-FOURTH COTSWOLD, SOUTH DAKOTA, 24255.

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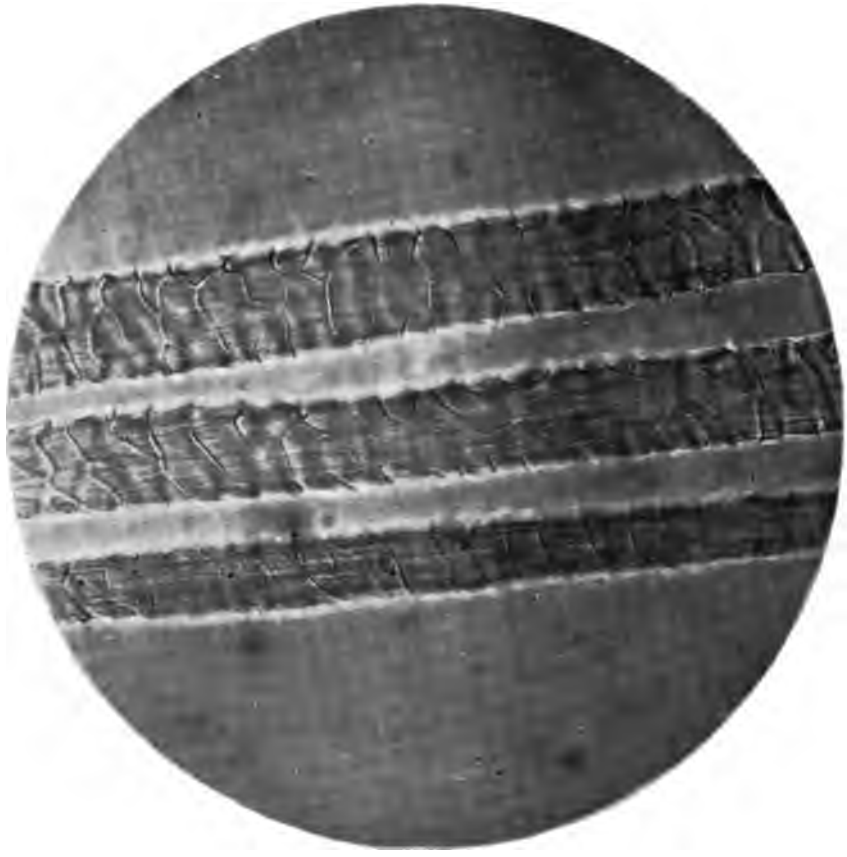

THREE-FOURTHS MERINO AND ONE-FOURTH LINCOLN, SOUTH DAKOTA, 24269.

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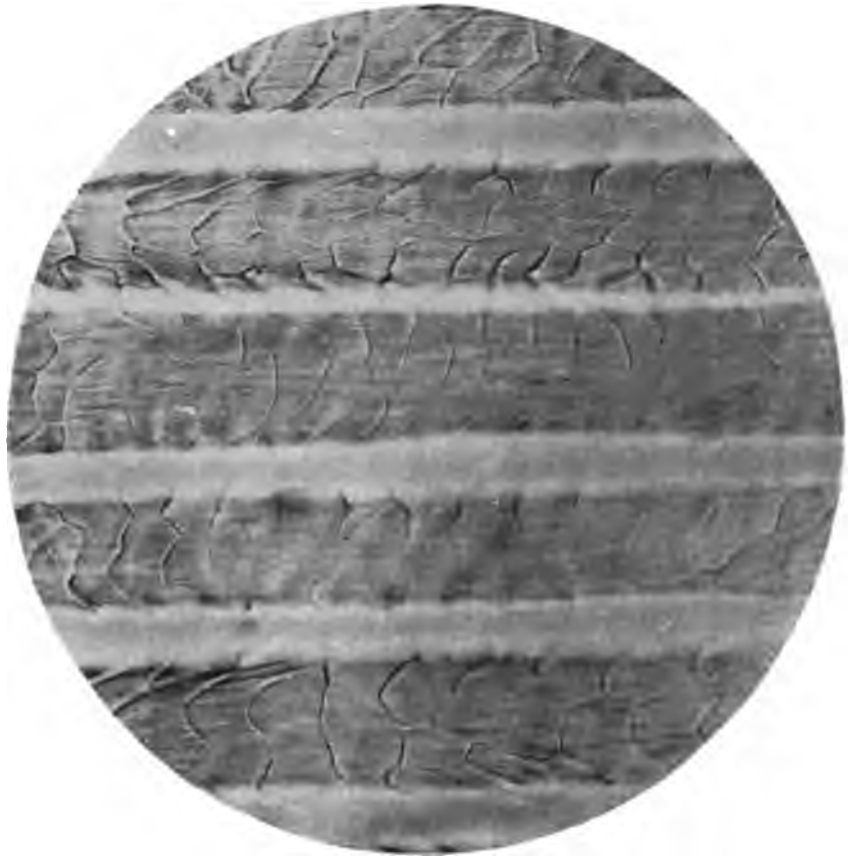
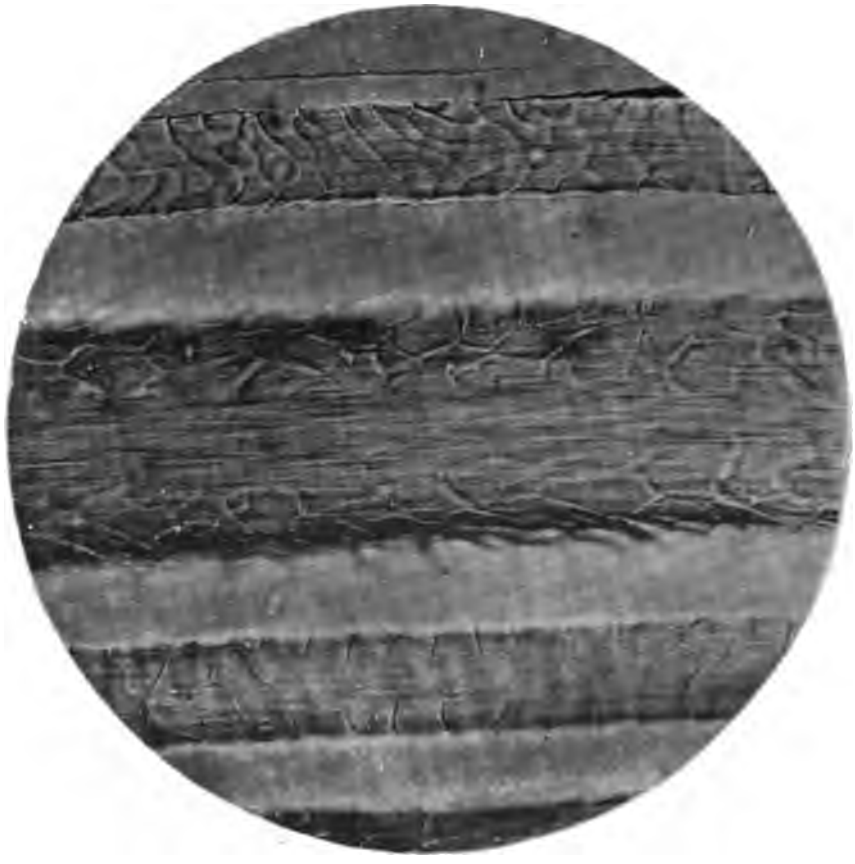


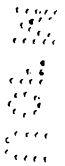
ONE-FOURTH MERINO AND THREE-FOURTHS LINCOLN, WISCONSIN, 3794.



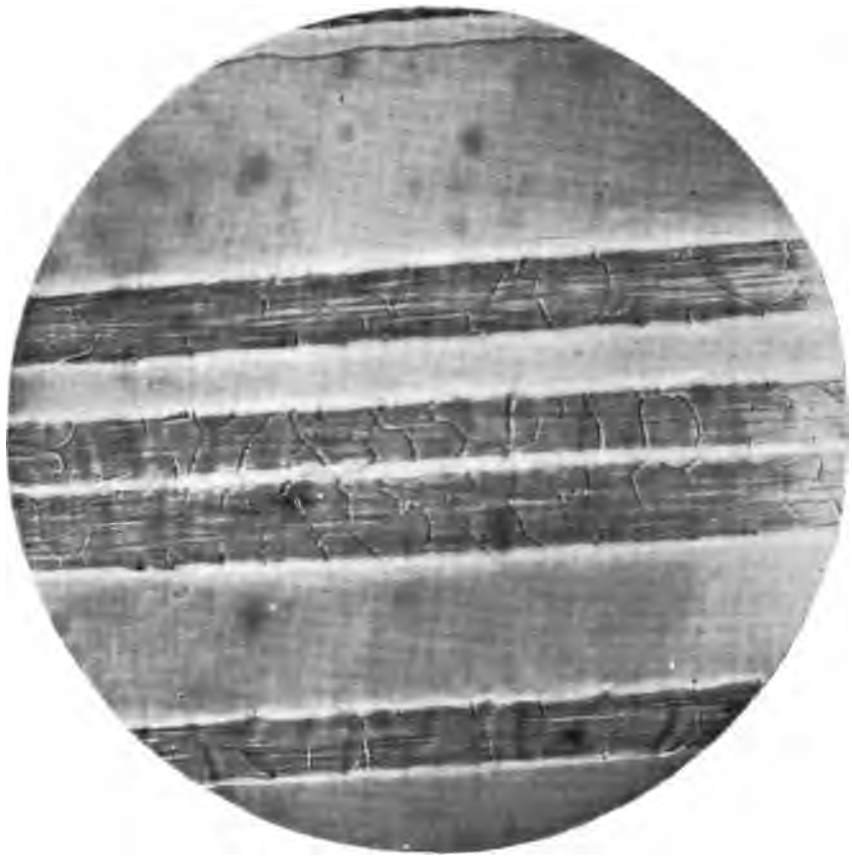
NATIVE, ECUADOR.

FLAT TAIL, TURKEY.

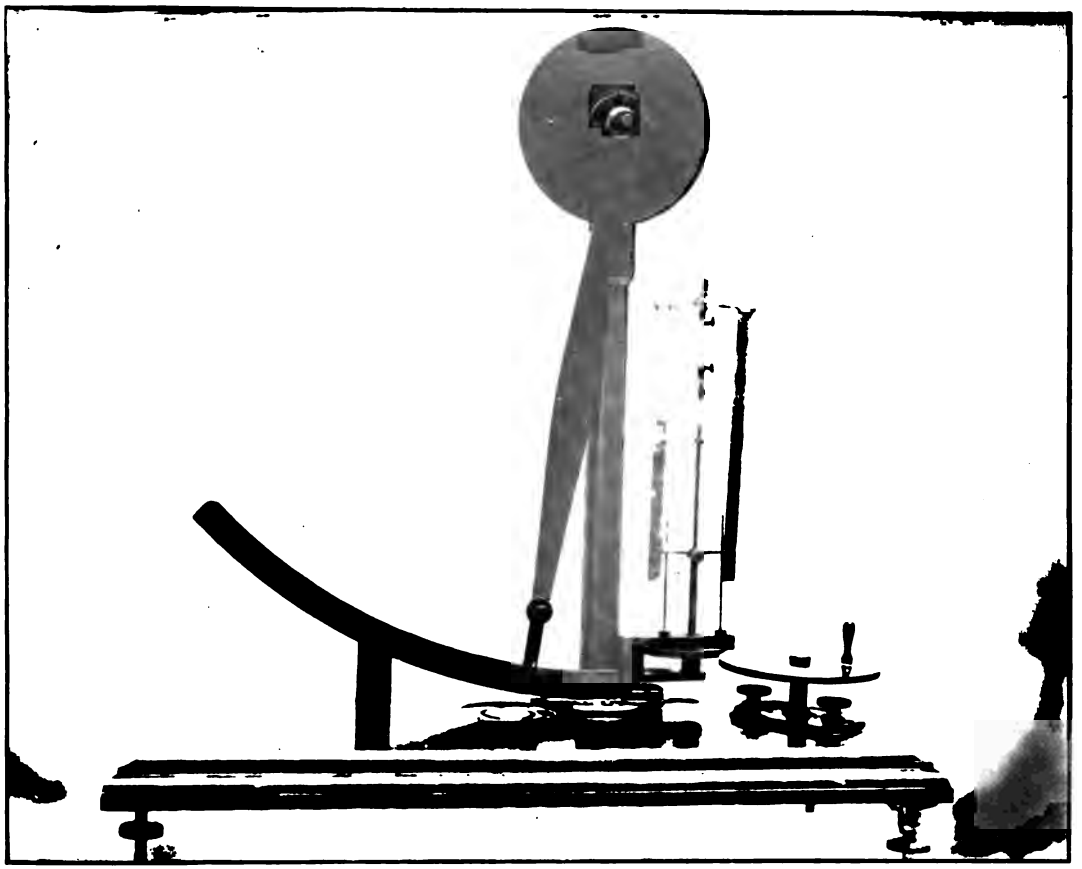
MOHAIR, TURKEY, 228.



ANGORA AND MERINO, RUSSIA.



ORENBURG GOAT, RUSSIA.



INSTRUMENT FOR THE MEASUREMENT OF STRENGTH AND ELASTICITY.

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YOM KIPPUR ON THE MIDWAY.

BY

ISIDOR LEWI.

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